FOOD TECHNOLOGY

PUBLISHED BY THE INSTITUTE OF FOOD TECHNOLOGISTS

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Affairs of the Institute

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Annual Meeting Bulletin Board
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Regional Section News

BUFFALO SECTION

The Section considered the values of local section meetings at its December gathering. Benefits derived from past professional meetings of the group were offered as follows (1) opportunities to get to know the industries located in the area and their top personnel, (2) association with men and women of high technical ability, (3) learning, through able speakers, of latest advances in food research and development, product development, economic trends, food business problems and possible solutions, and (4) the chance for the individual to develop his own abilities by informal discussion and by frequent contact with fellow workers in his field. Local sections provide also a benefit to local industry—namely, an opportunity to present to a highly professional group research problems and objectives that are normally too complex to interest less specialized groups. The December 5th meeting was held at Hotel Markeen, Buffalo.

PHILADELPHIA SECTION

The Philadelphia and Baltimore sections combined forces on November 11, 1955, for a joint meeting held at Wilmington, Delaware.

The meeting was held at the new Chestnut Run Laboratories of the Du Pont Company. In groups, members were taken on a tour of the Sales Technical Laboratories of the Film Division. Here they were shown how food packaging ideas are developed and tested in a most modern, well equipped laboratory. The laboratory consisted of various humidity and temperature controlled rooms, all sorts of electronic and electrical equipment, and mechanical devices to test stability of the foods, and its packaging film.

In the evening a social hour and dinner was held at the Du Pont Country Club. After dinner, Dr. Nelson Allen of the Du Pont Company spoke on "Film Packaging." With the aid of slides and a sound movie, Dr. Allen emphasized the need of selecting the proper film for packaging various foods. He devoted much of his time to discussing the physical characteristics of the new packaging film "Mylar," and its possible uses in industry.

The meeting was interesting, enjoyable, and informative and it was suggested that a combined meeting for the two sections be a yearly event.

MOHAWK VALLEY SECTION

At the September meeting held at Chris. Hansen's Laboratories, Little Falls, New York, the guest speaker of the evening was Mr. John Murphy, Division Sales Manager of Cherry Burrell Corporation. He described the advantages of bulk milk handling on the farm. These advantages were: better price to the farmer because the milk has a higher fat content and a lower bacteria count; hauling charges are lower; weight of milk delivered is increased due to less spillage and stickage; and the farmer is able to handle more cows and thus increase production. Mr. Murphy augmented his talk with slides.

NORTHEAST SECTION

Section holds Past Chairmen's Night. The Northeast Section of the Institute of Food Technologists held its first Past Chairmen's night at the Hotel Beaconsfield in Boston on December 1st, 1955.

This also was Ladies' Night and the attendance was over 125. The ladies were each given a flacon of perfume provided through the courtesy of Dodge and Olcott. In addition, flowers were presented to each lady. Door prizes of perfume, provided by Florasynth and Givaudan were also awarded.

Each past-chairman was presented a framed certificate of appreciation in recognition of valued service in behalf of food technology, as well as a bronze engraved gavel. Of the fourteen chairmen, only two were missing—Mr. Clarence Birdseye who is very ill and Dr. P. K. Bates. Dr. Bates, however, was well represented by his two sons, Charles and Bradford.

The list of the past chairmen is as follows:

1943-1944—Bernard E. Proctor
1944-1945—Philip K. Bates
1945-1946—Clarence Birdseye
1946-1947—Arthur C. Fay
1947-1948—William L. Campbell
1949-1950—Ernest C. Crocker
1950-1951—Newton R. Cole
1951-1952—Loren B. Sjöström
1952-1953—J. Avery Dunn
1953-1954—James Donovan
1954-1955—Jean F. Caul
1955-1956—Ernest E. Lockhart
1955-1956—W. Leverett Cummings

The feature speaker of the evening was the Section's first citizen, Dr. S. C. Prescott, who presented a beautifull account of the "Origins and Early History of IFT."

PERSONNEL

DANIEL C. MCCOY, consulting engineer, 7546 Normandy Lane, Dayton, Ohio, and a long-time member of IFT, is now providing consultation services on the technical phases of refrigeration for commercial and industrial uses, on the handling, transporting, and storing of perishables—with special attention to frozen foods, and on electronic heating and communications problems. Mr. McCoy, who recently retired from the Frigidaire Division, General Motors Corporation, has had many years of experience in providing technical counsel to support sales techniques and sales management.

The Vital Story of BREAKFAST CEREALS

with essential vitamins and minerals restored

by Science Writer

This article is one of a series devoted to the story of vitamin enriched or restored cereal products: white bread and rolls, white flour, corn meal and grits, macaroni products, white rice, breakfast cereals, farina.

Increasing in popularity over the years, breakfast cereals are used throughout the United States by young and old alike. Eaten with fruit and milk or light cream, they contribute an excellent combination of basic, flavorful, nutritious foods to the diet.

In the past decade the use of these fine foods has grown markedly. In fact, it is estimated that there has been a 20% increase during the period. In 1953 the increase was much higher than the average of previous years. It was 5.5%.

During 1953, for example, many tons of breakfast cereal foods were eaten in the United States. Industry figures show that 4.6 pounds of dry cereals and 2.5 pounds of hot (cooked) cereals per person were consumed.

Many grains are processed to make breakfast cereals: wheat, corn, rice, oats. Often these foods may be eaten just as they come from the manufacturer's package. Or they may require only a short period of cooking to be ready for the table. They appeal to busy home-makers, as well as to institutional dietitians, because they are readily available in a variety of flavors to add interest and value to an important, but sometimes neglected, meal.

A Nutritional Advance

As the science of nutrition advanced in recent years, it was found that losses of essential vitamins and minerals occurred during processing of wheat, corn and rice into breakfast foods. When this became known, most manufacturers acted to overcome the losses. They adopted restoration.

Restoration simply means that certain vitamins and minerals are added to the cereal food during processing so that the finished product is generally equal to the whole grain values of those elements. The vitamins thiamine (B_1), riboflavin (B_2), and niacin as well as the mineral, iron, are used in restoration. Vitamin D is also added sometimes.

The recent trend toward pre-sweetened cold cereals for breakfast consumption and between-meal snacks emphasizes the nutritional importance of vitamin fortification. Increased calories require more "B" vitamins for proper utilization.

What the Vitamins Do

Thiamine is the vitamin which helps to build and maintain physical and mental health. It is essential for normal appetite, intestinal activity and sound nerves.

Niacin, which is another of the "B" vitamins, is needed for healthy body tissues. Its use in the American diet has done much to make a serious disease called pellagra disappear.

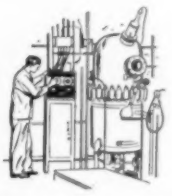
Riboflavin is the vitamin which is essential for growth. It helps to keep body tissues healthy and to maintain proper function of the eyes.

Vitamin D is important to prevent rickets in children and the development of certain abnormal bone conditions in adults.

Iron is essential for making good red blood and for preventing nutritional anemia.

Where Do The Vitamins Come From?

At about the same time that processing losses in breakfast cereals became known, other developments in the science of nutrition produced ample supplies of vitamins at economical prices. Thus, the quality of breakfast cereal foods could be, and was, greatly improved through restoration.



Since the early days of breakfast food restoration and of white flour and white bread enrichment, the world-famous firm of Hoffmann-La Roche has supplied top quality vitamins by the tons. Pioneering work in its laboratories and by its collaborators resulted in the "duplication" of some of Nature's extremely complex substances. First, the chemical composition of the vitamin was learned. Second, the pure substance was isolated. Third, the "duplicate" was made by synthesis. And fourth, the laboratory techniques were extended to large scale operations.

The manufactured "duplicate" is identical chemically and in biological activity with Nature's own product. A vitamin is still a vitamin regardless of its source. So efficient is large scale manufacturing that vitamins are sold at a lower cost than if they were extracted from natural sources.

Reprints of this article, and of all others in this series, are available without charge. Please send your request to the Vitamin Division, Hoffmann-La Roche Inc., Nutley 10, New Jersey. In Canada: Hoffmann-La Roche Ltd., 286 St. Paul Street, West: Montreal, Quebec.

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Annual Meeting Bulletin Board

Abstracts of papers due February 1, 1956. Abstracts of annual meeting papers to be presented at St. Louis, Missouri, June 10-14, 1956 must be sent to Dr. R. J. Sumner, Care of Central Research Department, Anheuser-Busch, Inc., St. Louis 18, Missouri prior to February 1, 1956. The deadline of February 1 was set by the Program Committee in order that the program may be printed in the May issue of FOOD TECHNOLOGY and be made up in booklet form for use at the meetings. Titles of papers have already been submitted for the various sessions, some sixteen in all, on food and food packaging problems.

1956 Program Committee. The names and affiliations of the 1956 Program Committee follow:

Chairman: Dr. R. J. Sumner, Director, Central Research Department, Anheuser-Busch, Inc., St. Louis 18, Missouri.
Dr. E. A. Beavens, In Charge, Fruit and Vegetable Chemistry Lab., U. S. Dept. of Agriculture, 263 South Chester Avenue, Pasadena 5, California.
Professor D. E. Brady, Department of Animal Husbandry, University of Missouri, Columbia, Missouri.
Dr. G. S. Bratton, Technical Adviser to the President, Anheuser-Busch, Inc., St. Louis 18, Missouri.
Dr. S. M. Cantor, Sidney M. Cantor Associates, Suburban Square Building, Ardmore, Pennsylvania.
Dr. Domenic DeFelice, Research Manager, General Foods Corporation, Associated Products Division, White Plains, New York.
Dr. George Garnatz, Director, The Kroger Food Foundation, 1212 State Avenue, Cincinnati 4, Ohio.
Dr. I. J. Hutchings, Manager of Food Research, H. J. Heinz Company, Pittsburgh 30, Pennsylvania.
Dr. Robert A. Larsen, Assoc. Mgr., Department of Scientific Research and Technical Development, Pillsbury Mills, Inc., Minneapolis 2, Minnesota.
Dr. Bruce H. Morgan, Quartermaster Food & Container Inst., 1819 West Pershing Road, Chicago 9, Illinois.
Mr. John H. Nair, Asst. Director of Research, Thomas J. Lipton, Inc., Hoboken, New Jersey.
Dr. A. N. Prater, Vice President, Gentry Division, Consolidated Foods Corporation, Box 2076, Terminal Annex, Los Angeles 54, California.
Mr. H. P. Schmitt, Natl. Assn. of Frozen Food Packers, 1415 K Street, N. W., Washington 5, D. C.

General Foods Fund Inc. Fellowship Awards for 1956-1957

Funds for these Awards are provided by The General Foods Fund, Inc., 250 Park Ave., New York 17, N. Y., a charitable foundation supported by General Foods Corporation, to establish a graduate fellowship program in the field of food science to be administered by The Institute of Food Technologists, Inc. The fellowships are granted annually—no more than two to the same educational institution for the same calendar year. They are renewable upon application to and approval by the Awards Committee for a maximum of three years, in order to provide for continuity of studies leading to a doctorate degree, if the candidate so plans. However, candidates who plan only a year of research after obtaining the Bachelor's Degree, or who plan to read for a Master's Degree, are not excluded from these fellowship grants.

Candidates for these Fellowships are selected by the Committee on Awards from a roster listing all applicants submitted by and endorsed by the graduate schools where the applicants plan to pursue their studies. These Fellowships are administered by the Institute through the office of the Secretary of the Institute with the advice and counsel of the Chairman of the Awards Committee.

Fellowships are awarded annually, three each year, to deserving and outstanding United States or Canadian citizens, engaged in senior undergraduate or graduate work in recognized educational or research institutions in the United States of America or Canada, in basic or applied chemistry, chemical engineering or related sciences, which may involve new physical or other procedures, directed to extending or improving knowledge in some phase of food conservation, food production or food processing, rather than primarily for research in the fields of nutrition, bacteriology or analytical chemistry.

Applications must be in letter form, giving the customary essential personal and academic information with respect to the applicant:

A. Name, nationality, sex, age, marital status, physician's statement with respect to the general health and physical condition of applicant.

B. Educational and experience background, college or university scholarship record, noteworthy accomplishments in research and the purpose of applicant in applying for Fellowship Award.

In order to qualify, the applicant must be a senior undergraduate student, with better than average scholastic record at an institution of resognized standing; or, a graduate student with a B.Sc. or equivalent, preferably with honors, from an institution of recognized standing. In either case, the applicant must have an approved plan of research in Food Technology and acceptance by the Graduate School of the institution in which the applicant proposes to hold the Fellowship. In presenting his application, the applicant should indicate his definite intention, on his word as a gentleman, to carry through with his approved research plan for the period of time for which the Fellowship Award is made insofar as it is humanly possible.

Three letters of recommendation must be forwarded separately to the Office of the Secretary of the Institute by Deans, Heads of Departments and/or Professors who have supervised research work of the applicants. These letters should present essential facts regarding the scholarship or record transcript thereof, character and personality, ability to cooperate and capacity for work and achievement of the applicants. Also needed is a statement by the Head of the Department where the work will be done, endorsing the applicant and accepting for the school the responsibility connected with the acceptance of the Fellowship Award.

The Awards for the Fellowship are for the full calendar year and the total of the award shall be paid to the school at the beginning of the initial school term. This award will be used for three purposes: (a) to pay for

(Continued on page 6)

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GENERAL FOODS FUND INC. FELLOWSHIP AWARDS FOR 1956-1957

(Continued from page 4)

living expenses of the chosen student at a minimum rate of $200/month ($2,400/year); (b) to pay all academic fees for the student and (c) the remaining moneys will be allocated to the department fund in the department in which the student is working.

Applications for Fellowship Awards must be received at the Office of the Secretary of the Institute, not later than February 1st, 1956.

The names of the recipients of the Fellowships will be announced by the President of the Institute at the Annual Meeting of the Institute at St. Louis in June.

Books

HUNGRY PEOPLE AND EMPTY LANDS. S. Chandrasekhar, with a foreword by William Vogt. 306 pages. George Allen and Unwin Ltd., London. Distributed by Macmillan. 1954.

Most of the several scores of books which appeared during the past two or three years on the world food problem were written by Westerners. The present passionate and somewhat uneven study is by a Professor of Economics at the University of Baroda in India. Briefly, the author wishes to correct the present "demographic disequilibrium" by mass migration of "hungry people" from the densely populated countries to the so-called "empty lands."

There is much to disagree with in the premises of this thesis. The "hungry people" are not so because of the malice and avarice of others or on account of racial prejudices although at times these might have been contributing factors. Nor can one objectively say that colonialism (abhorrent as it sounds to us Americans) is responsible for the world's ills. More often than not, it is the lack of development (both technical and social) which resulted in the present "disequilibrum." Dr. Chandrasekhar concerns himself a great deal with India and therefore it is appropriate to note the vast unutilized human and national resources of his country. India *is* taking the path of technical and economic development, as all who read their daily paper well know. There is no short-cut or magic scheme to solve this problem of imbalance and only calm thinking and hard work will count in the long run. Fortunately, this is the approach used by most so-called "underdeveloped" countries. In fairness one must also state that apparently much of the book was written before 1952, and from the few obviously later added discussions one almost wonders whether the author would agree with his thesis today.

The sociological limitations of large-scale migrations are completely overlooked in this discussion. So are the economic consequences, such as the inevitable upsetting of the precarious wage-production-consumption patterns in the more developed parts of the world. The severe limitations imposed on food production by lack of the proper combinations of soil, climate, rainfall, etc. are also not given proper weight.

Let us face it, the formula advocated in this book will not solve the human race's frightful dilemma—but none of the many other books on this subject was able to suggest a simple and easy path, either. The important thing is that we are at last facing up to the problem. Dr. Chandrasekhar's book will certainly stimulate discussion and thus should be regarded as a catalyst of progress.

Z. I. KERTESZ
Geneva, New York

CATALYSIS. VOLUME III. HYDROGENATION AND DEHYDROGENATION. Paul H. Emmett, Editor. Reinhold Publishing Corp., New York, 1955. 504 pages.

In volumes I and II the theoretical aspects of homogeneous and heterogeneous catalysis have been discussed. In this and in subsequent volumes operational and factual phases of catalytic reactions are stressed. The subject matter of volume III is primarily a discussion of those reactions in which hydrogen is simply added to unsaturated bonds without the simultaneous ejection of such molecules as water or hydrogen sulfide and without hydro cracking. Several chapters are devoted to the catalytic hydrogenation of ethylene, olefinic hydrocarbons, the carbon-carbon triple bond and nitro compounds. The synthesis of ammonia from nitrogen and hydrogen, synthesis of methanol and catalytic dehydrogenation are also covered. Of particular interest to Food Technologists is a chapter by R. O. Feugh on the hydrogenation of glyceride oils. This chapter, which contains 99 references to the original literature, deals primarily with the type of catalysts used, their preparation and behavior of the components of an oil during hydrogenation.

Although this book is written most lucidly it could have been improved by the use of illustrations particularly of the industrial installations and of the apparatus needed for catalytic hydrogenation.

ERNEST SONDHEIMER
Geneva, New York

LIVSMEDELSTEKNIK (Swedish Journal for Food Technology and Food Industry News) Wezäta Förlag, Lasarettsgatan, 6, Gothenberg, Sweden.

LIVSMEDELSTEKNIK is the only Swedish publication entirely devoted to food technology. Published 6 times a year, it has a circulation of 10,000. It is distributed mainly in Sweden, but it also reaches readers in Norway, Denmark, and Finland, as well as other continental countries. Edited by Professor Georg Borgstrom, the journal lists on its board of editors such names as Edy Velander, famed scientist and Director of the Swedish Academy of Engineering Science, Professors Ernst Abramson, Erich Adler, Harry Lundin, Ollof Mellander, Karl Myrbach and Ragnaar Nilson.

LIVSMEDELSTEKNIK has set as its purpose to "systematically follow developments within all branches of food technology," to "convey the results of food research abroad," and to "encourage debate of current problems." A recent issue (September 1955) treated among others the following subjects: Canning of Ham; Dried Potato Products; Diet Increases the IQ; Manu-

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BOOKS

(Continued from page 6)

facture of Freezers; and "Hot Air" Canning. The last-mentioned article deals with a new method of food sterilization developed by Einar Ekelund, a Swedish engineer. The first process of this type in the world, it has recently been put into use by a dairy in Kalrineholm, Sweden.

The "Special Features Section" includes various items of interest from around the world, collected under the headings: Literature, Food News, Industrial News, Sanitary Packaging, and "Noted." A section devoted to debatable issues is at present analyzing the question "Frozen bread: anything for Sweden?" American technical journals which do not ordinarily provide so clear-cut an opportunity for reader participation, might take a cue from this interesting section.

The magazine provides a thorough coverage of foreign food technological developments (the U. S. is prominently featured) and there are several articles from sources outside Sweden that contribute importantly to food science and technology.

A study of LIVSMEDELSTEKNIK and its advertising gives a good insight into what commodities are of special importance in the European Far North. An article relating to dried potato products illustrates that this vegetable is a substantial component of the Scandinavian diet. Frozen fish products are lavishly advertised as are other products of the sea. This brings to mind the fact that marine foods are consumed in the Far North to an extent that puts the meat-loving U. S. far behind in the statistics. Bread is honored with a special annex to the magazine — and what would a Swede do without Smörgäs (open-faced sandwich)?

Summing things up, LIVSMEDELSTEKNIK is a well-edited, handsomely styled publication, which serves its readers an attractive "smörgasbord" of substantial items from the world of food technology.

ROGER S. ARNESON
Chicago, Illinois

MICROBIOLOGY, by E. A. Gray. Philosophical Library, Inc., 15 East 40th St., New York, 175 pp. 1955.

This little book was designed as an introduction to Microbiology, and was not intended to compete with works which cover in detail the various fields of the subject. The author has succeeded in clearly indicating how various organisms are intimately associated in nature. Short chapters on the biology of microorganisms, the culture and control of microorganisms, and the host-parasite relationship of cells define many basic concepts and terms used in microbiology. The chapters on algae, protozoa, microbiology of soil, and microbiology of inland waters and the sea are excellent. The discussions on viruses, bacteria, and yeasts, molds and fungi follow a definite outline form, and would have been improved by a little more detail. In general, the book is well written, and is recommended to beginners in microbiology who want a concise, elementary discussion of the subject.

R. O. WAGENAAR
Chicago, Illinois

Florasynth Fellowship Award for 1956-1957

Provided by the Florasynth Laboratories Inc., New York, N. Y., and given annually to some outstanding individual for the advancement of Food Technology, the $1000 Florasynth Fellowship Award is now open for qualified applicants. Nominees are selected by Department heads who are supervising the work of a candidate in a recognized college or university.

The Florasynth Fellowship is granted annually, to a young man or woman, under 35 years of age, engaged in senior undergraduate or graduate work, as a candidate for an advanced degree, in a recognized educational institution in the United States of America or Canada, which is conducting fundamental investigations for the advancement of Food Technology. The Fellowship Award is made annually to a person in a different institution each year, except that after three years, this Fellowship may be granted to a person studying in an institution where the Fellowship has been held previously.

Candidates for the award are selected by the Committee on Awards. The Fellowship is administered by the Institute through the Office of the Secretary of the Institute, with the advice and counsel of the Chairman of the Commitee.

Procedure. Nomination for the Fellowship Award is made to the Office of the Secretary of the Institute, in behalf of the proposed candidate, by the head of the Department who supervises the undergraduate or graduate work of the candidate. Application must be made in letter form, giving the customary essential personal and academic information with respect to the candidate:

A. Name, nationality, sex, age, marital status.

B. Educational and experience background, college or university scholarship record in transcript, noteworthy accomplishments in research, reasons for proposing the candidate for the Fellowship Award.

In order to qualify, the candidate must have a better-than-average scholastic record/and or a B.Sc. or equivalent, preferably with honors from an institution of recognized standing and shall have unusual qualities of character and ability in research.

The Fellowship Award is for the academic year. Nominations for the Fellowship Award for 1956-57 must be received at the Office of the Secretary of the Institute not later than February 1st, 1956. Selection of the winner is made by the Committee on Awards.

The name of the successful candidate is given to the President of the Institute who notifies the candidate with a copy of his letter of notification to the Head of Department who proposed the name of the candidate. The name of the recipient of the Fellowship Award will be announced by the President of the Institute at the Annual Meeting of the Institute in St. Louis, in June, 1956.

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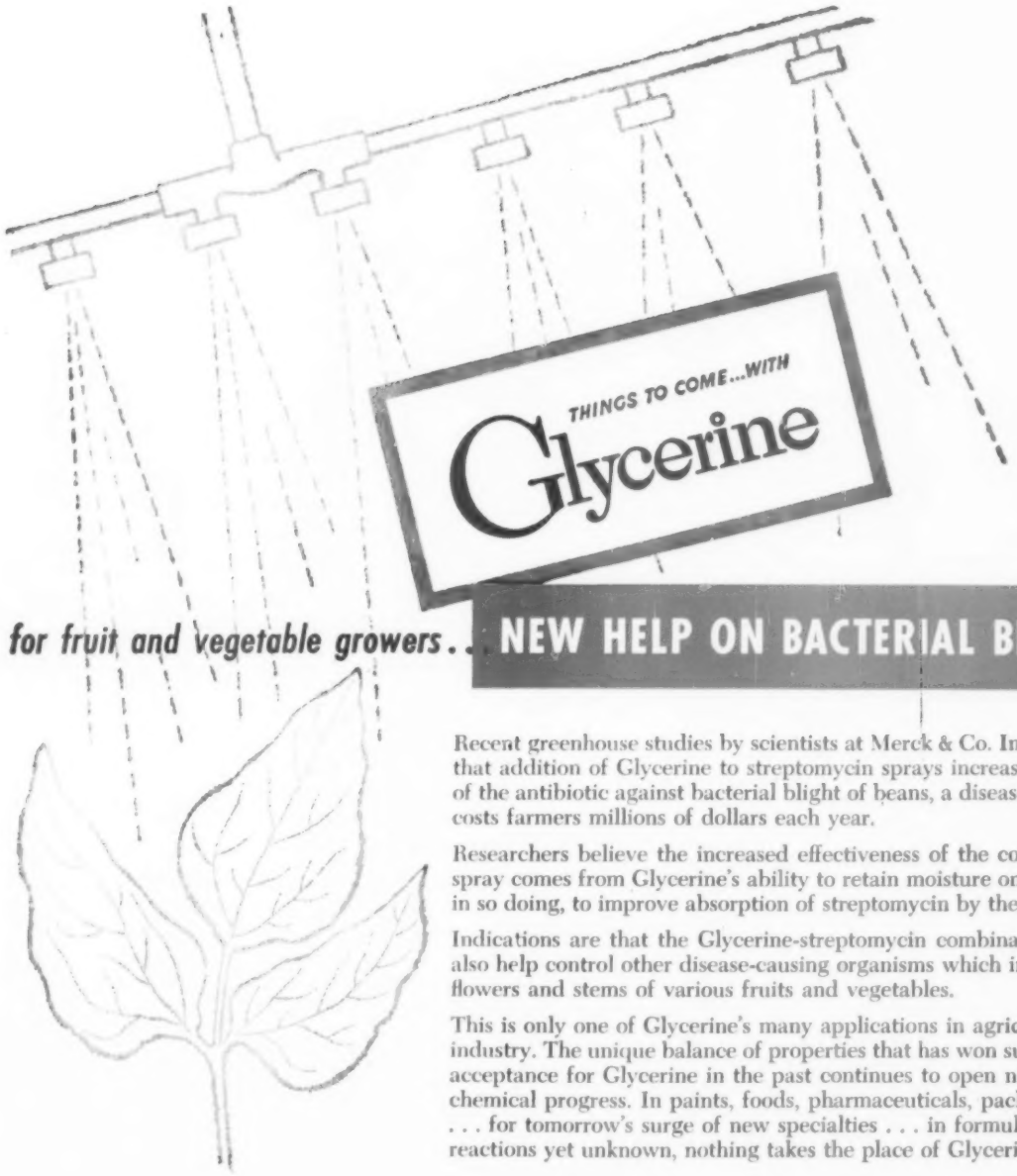

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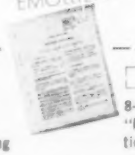

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Gerber Baby Foods $6,000 Post-Doctorate Fellowship (1957)

The Gerber Baby Foods Fund of Fremont, Michigan, a charitable foundation supported by Gerber Products Company, has established a Post-Doctorate Research Fellowship in the field of food science, to be administered by The Institute of Food Technologists, Inc. Winner of the first award was Dr. Austin C. Wagenknecht, Department of Food Science and Technology, New York State Agricultural Station, Cornell University, Geneva. The Fellowship was established for the purpose of promoting research in some newer phase of food technology.

Applications are in order for the second Gerber Award (1957) and any citizen of the United States or Canada holding a Ph.D. degree or an equivalent academic degree and having the necessary qualifications to undertake post-doctorate studies in a recognized educational or research institution may apply for the Fellowship. The applicant must be acceptable to the institution in which he plans to pursue his studies.

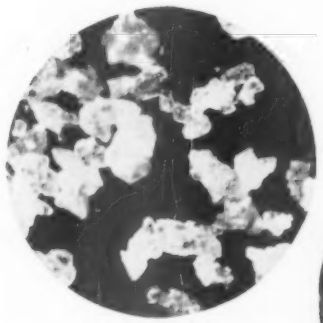
The Fellow will be selected by the Institute of Food Technologists Committee on Post-Doctorate Awards after review of all of the applications submitted. The Committee will make their selection based upon the candidate's ability, as judged from his previous performance and personal references, as well as their judgment of the potential value of the proposed research in the advancement of knowledge and human welfare. The Committee is guided by the general policy of selecting awardees who are not only well qualified in their particular field, but are capable of evaluating the nutritional aspects of their research. Although the Fellowship need not be limited to nutritional research, nutritional aspects should not be neglected.

The application for a Fellowship must be in letter form giving the customary essential personal and academic information with respect to the applicant. The application and supporting papers must be submitted in duplicate.

In addition, the application should present a research program stating the purpose of the research and its significance as well as a brief outline of the experimental procedure for accomplishing these objectives.

The application must also be accompanied by a letter of acceptance from the Head of the Department in which the work will be done.

Candidates should have at least three persons, under whose instruction they received their advanced degree, send confidential letters of support to the Executive Secretary, Institute of Food Technologists. These letters should cover in detail the previous work of the applicant and an evaluation of his suitability to undertake the proposed research. Address applications to the Executive Secretary, Institute of Food Technologists, 176 West Adams Street, Chicago 3, Illinois.



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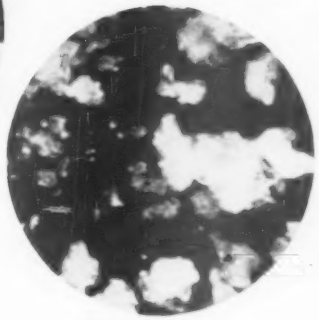

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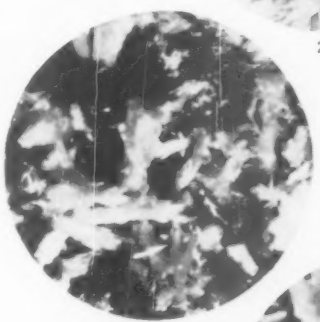

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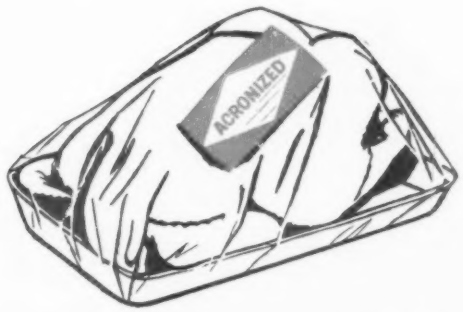

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Selected Abstracts*

ANALYTICAL METHODS

A comparative study of some methods of determining salicylic acid in blood serum.

BARBEZAT, G. *Anal. Chim. Acta, 13,* 83-8 (1955).

If one deproteinizes blood serum by Na tungstate and H_2SO_4 the excess tungstate impedes the formation of the colorless complex of salicylic acid with the Fe. One can use this method if sufficient concn. of Fe is present to eliminate all tungstate. The most satisfactory method consists of extg. the salicylic acid by dichloroethylene and bringing it into aq. soln. by means of a ferric soln.

Vegetable oils. IV. A new method of determining the component acids of oils containing epoxy- and/or hydroxy-acids.

BHARUCHA, K. E., AND GUNSTONE, F. *J. Sci. Food Agr., 6,* 373-80 (1955).

A new method of detg. the component acids of oils contg. epoxy- and/or hydroxy-acids is described and applied to the seed oils of *Veronia anthelmintica* and *Strophanthus hispidus* contg. 12:13-epoxyoctadec-9-enoic (74%) and 9-hydroxyoctadec-12-enoic acid (15%) respectively. Some new derivs. of this latter acid are reported and the periodate method of detg. α-glycols is criticized.

The determination of acrolein in the presence of other aldehydes.

VAN SANDT, W. A., GRAUL, R. J., AND ROBERTS, W. J. *Ind. Hygiene, 32,* 221-4 (1955).

A polarographic analysis of acrolein adsorbed on silica gel was presented. The method is specific for acrolein, and the common aldehydes do not interfere. What would be a fairly simple analysis is complicated by the necessity for using air-free conditions because of the high volatility of acrolein.

Determination of sodium carboxymethylcellulose.

SZALKOWSKI, C. R., AND MADER, W. J. *J. Am. Pharm. Assoc., Sci. Ed., 44,* 533-5 (1955).

A method for the detn. of Na carboxymethylcellulose in antibiotic prepns. The Cu salt of carboxymethylcellulose is pptd. and analyzed for carboxymethylcellulose colorimetrically using 2,7-naphthalenediol. Possible use of this method in quant. detn. of carboxymethylcellulose is suggested.

BIOLOGICAL SCIENCES

BIOCHEMISTRY

Observations on the specificity of yeast iso-amylase.

MANNERS, D. J., AND KHIN, M. *Chemistry & Industry, 30,* 950-1 (1955).

Details are given for the isolation of iso-amylase. The enzyme catalyzes the hydrolysis of a proportion of 1:6 linkages in glycogen, β-dextrin and malto-dextrin.

Further studies on the purification of prostatic acid phosphatase.

LONDON, M., SOMMER, A., AND HUDSON, P. *J. Biol. Chem., 216,* 81-95, September (1955).

A new method of purifying the prostatic acid phosphatase was presented. Fullers' earth was used for purifying the enzyme. The process was made feasible by protecting the enzyme with a non-ionic surface-active agent. The ion exchange properties of the enzyme are presented. A highly purified product was obtained by chromatography.

Kinetics of protein denaturation.

STAUFF, J., AND UEHLEIN, E. *Kolloid-Z., 143,* 1-21 (1955).

Heat denaturation of β-lactoglobulin was studied by means of light scattering. The authors recognize four periods in this process of heat denaturation.

Glucose as a precursor of amino acids in the intact dairy cow.

BLACK, A. L., KLEIBER, M., AND BAXTER, C. F. *Biochim. et Biophys. Acta., 17,* 346-53 (1955).

A lactating dairy cow was injected intravenously with 2.9 millicuries of uniformly C^{14}-labeled glucose. The specific activity was detd. for plasma glucose and for amino acids of casein during the subsequent 34 hrs. and these data were used to evaluate glucose as a precursor of amino acids. Glucose C was transferred most rapidly and in largest amt. to the three carbon amino acids, alanine and serine. Calcns. indicated that 25% of alanine and serine, 10% of aspartic and glutamic acids, and 7% of glycine was derived from plasma glucose. Proposed pathways for the transfer of C from glucose to the amino acids are discussed. The amt. of glucose C transferred to the amino acids via the plasma CO_2 pool was evaluated.

Relations between the molecular structure and the inhibition power of the nitro and halophenols.

DE DEKEN, R. H. *Biochim. et Biophys., Acta, 17,* 494-502 (1955).

The inhibition of the phosphorylations and the fermentation of yeast resulting from the action of numerous nitro-and halophenols was measured. The relations existing between mol. structure and biol. activity are outlined. The inhibition power is a function of the mobility of the proton; a low pK is favorable, whereas chelation with a ring substituent in ortho position weakens the inhibitory activity. Two other factors act on the penetration of the mol. into the cell: a low extracellular pH is favorable, since the phenols penetrate as undissociated mols., and a high liposolubility of the derivate also facilitates its penetration. The measured inhibition is the resultant of these factors.

A note on the effect of aureomycin on the response of the rat to vitamin D.

MURRAY, T. K., AND CAMPBELL, J. A. *Can. J. Biochem. & Biophys., 33,* 797-9 (1955).

The response of rachitic rats to doses of vitamin D, as measured by the line test, was increased by the addn. of aureomycin to the rachitogenic diet. The wt. gain of these animals was also increased by the antibiotic. In the absence of vitamin D aureomycin had no effect on either calcification or wt. gain.

MICROBIOLOGY

Supplementation of media with yeast culture for counting anaerobic spores.

ADAMS, A. T., AND AYRES, J. C. *Appl. Microbiol., 3,* 226-30 (1955).

Media supplemented with culture of *Saccharomyces cerevisiae* showed marked reduction in spore germination lag.

Studies on growth and toxin production of Clostridium botulinum in a precooked frozen food. I. Some factors affecting growth and toxin production.

SALEH, M. A., AND ORDAL, Z. J. *Food Research, 20,* 332-9 (1955).

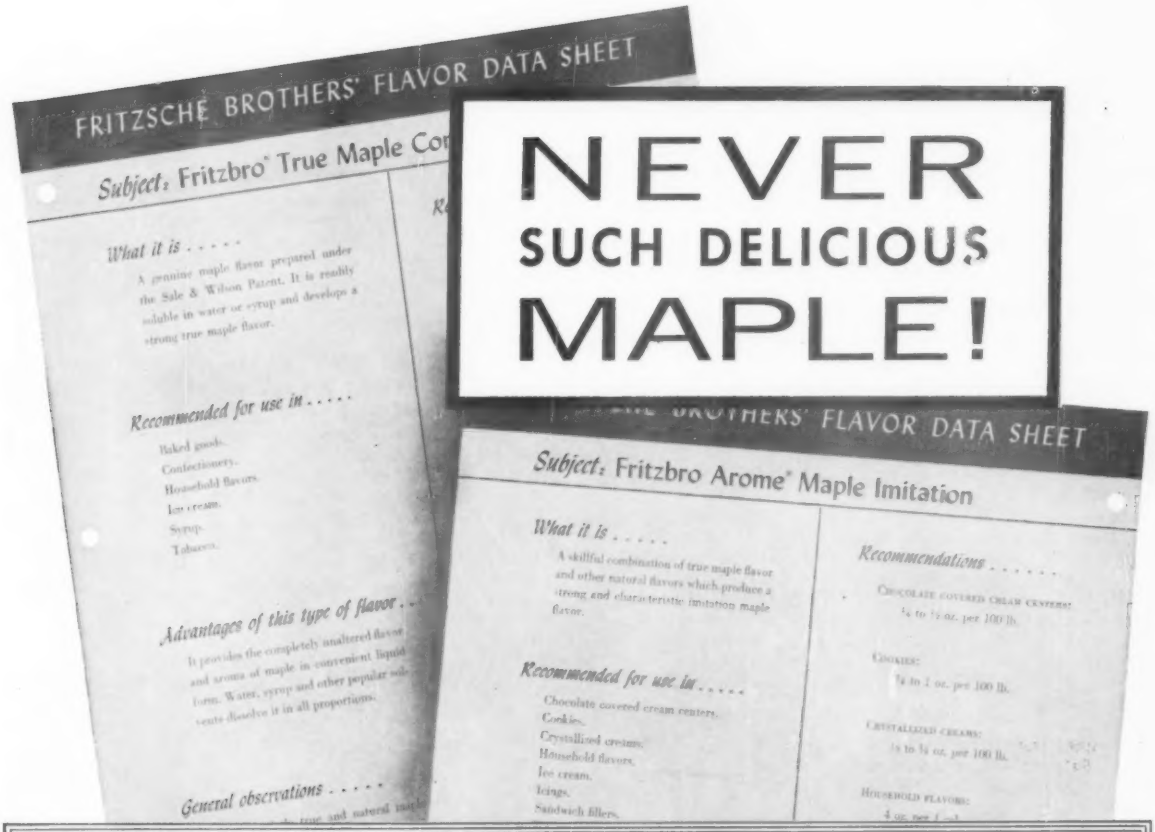
"Chicken a la king" incubated at 86° F. showed toxin in some samples which received no inoculum with spores indicating the possibility of a *botulinum* hazard when precooked frozen foods are mishandled. No toxin was formed during freezing or thawing in samples stored at 50° F.

Some nutritional aspects of bacterial recovery from ionizing radiations.

STAPLETON, G. E., SBARRA, A. J., AND HOLLAENDER, A. *J. Bacteriol., 70,* 7-14 (1955).

(Continued on page 18)

* These Selected Abstracts are made available to FOOD TECHNOLOGY through the cooperation of Dr. H. A. Campbell and the General Foods Corporation of White Plains, N. Y. The abbreviations found in these abstracts are similar to those used by Chemical Abstracts.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SELECTED ABSTRACTS

(Continued from page 16)

The B/r strain of *Escherichia coli* grown on a complete medium such as nutrient broth showed radiation induced requirements for nutritional factors. Some evidence was presented which indicates that the bacteria showing the nutritional requirements are not stable auxotrophic mutants. A chemically defined medium was developed which will substitute for natural materials in bringing about recovery. The data suggest that the recovery process investigated is related to the synthesis of new enzymes in the irradiated cell.

The action of subtilin on heated bacterial spores.

MICHENER, H. D. *J. Bacteriol., 70,* 192-200 (1955).

During short heat treatments at 85° C. or 100° C., spores of 11 out of 14 strains of bacteria tested were more sensitive to a combination of subtilin and heat than to heat alone. Heated spores of *Bacillus subtilus* strain 9524 retained increased subtilin sensitivity for at least 22 days. Unheated spores were less sensitive to subtilin than heated ones. The effect of subtilin increased with concn. in the range of 2 to 20 p.p.m. Spores which were incubated with subtilin under conditions which are unfavorable to germination (absence of nutrients, temp. too high) frequently survived and could be detected by plating. Under conditions favorable to germination, spores of *B. subtilis* did not survive incubation with subtilin. Subtilin is adsorbed on ungerminated spores, but the spores are not affected by it until they are placed in an environment which causes them to germinate.

A modified selenite brilliant-green medium for the isolation of Salmonella from egg products.

OSBORNE, W. W., AND STOKES, J. L. *Applied Microbiol., 3,* 295-9 (1955).

The selectivity of selenite brilliant-green medium for the isolation of *Salmonella* is decreased by egg products. This modified sulfapyridine enrichment broth is sufficiently selective and sensitive to permit isolation of *Salmonella*, even when only one viable cell is present in 100 g. of com. naturally contaminated dried egg. The addn. of 0.1% sulfapyridine to brilliant-green agar enhances its selectivity for *Salmonella*.

The sterilization of carbohydrates with liquid ethylene oxide for microbiological fermentation tests.

JUDGE, L. F., AND PELCZAR, M. J. *Applied Microbiol., 3,* 292-4 (1955).

Carbohydrates routinely employed for bacteriological fermentation tests can be conveniently and effectively sterilized by liquid ethylene oxide. No deleterious effect on the carbohydrates could be detected by microbiological or chem. tests. This method of sterilization provides results comparable to those obtained with filter-sterilized sugars and has the advantage of simplicity of performance.

Direct antagonism in mixed bacterial populations.

CHARLTON, G. *J. Bacteriol., 70,* 56-9 (1955).

The mechanism of direct antagonism in mixed bacterial populations was examd., and it was found that inhibition of growth does not arise as a result of direct contact between organisms nor is it caused by the production of an antibiotic substance. Evidence is presented to show that the antagonism is due to competition for gaseous nutrients in the medium.

NUTRITION

Importance of amino acid balance in nutrition.

ELVEHJEM, C. A., AND HARPER, A. E. *J. Am. Med. Assoc., 158,* 655 (1955).

Comments on the importance of amino acid balance in nutrition and some observations on the types of amino acid imbalance which may be encountered.

The amino acid requirements of man. X. The lysine requirement.

ROSE, W. C., BORMAN, A., COON, M. J., AND LAMBERT, G. F. *J. Biol. Chem., 214,* 579-87 (1955).

Six expts. have been conducted upon normal young men for the purpose of establishing their minimal L-lysine requirements, as measured by the N balance technic. Results show that the subjects required from 0.4 to 0.8 gm. of this amino acid per day. In accordance with the practice followed in similar investigations involving other amino acids, it is proposed that the highest observed value, or 0.8 gm., be designated tentatively as the minimal daily L-lysine requirement of man.

The biological value of oils and fats. I. Growth and food intake on feeding with natural oils and fats.

THOMASSON, H. J. *J. Nutrition, 56,* 455-67 (1955).

In 6-week feeding expts. with rats the behavior of 20 oils and fats was investigated, each of them being administered in 7 different dosages from 10 to a max. of 73 Cal. %. The various oils and fats showed differences in growth-promoting effect. Nevertheless, the food-efficiency seemed to have a constant value and to be independent of the type of fat used. Only shea butter and palm oil were exceptions to this rule. As an explanation of the differences observed the presence of growth-inhibiting substances is suggested. Such substances need not be considered as harmful, but may possibly even exert a favorable influence, judging from the data on longevity.

The biological value of oils and fats. II. The growth-retarding substance in rapeseed oil.

THOMASSON, H. J., AND BOLDINGH, J. *J. Nutrition, 56,* 469-75 (1955).

Comparison of the growth-promoting effect of nasturtium seed oil, contg. 86% of erucic acid, with that of rapeseed oil (about 50% erucic acid), as well as detn. of the effect of erucic acid on growth, or of fat mixts. contg. tri-erucin, has shown that the unfavorable growth obtained with rapeseed oil must be ascribed to the erucic-acid content of this oil.

The influence of dietary fat on thiamine loss from the body.

HOLT, L. E., AND SYNDERMAN, S. E. *J. Nutrition, 56,* 495-500 (1955).

Studies carried out in human infants revealed that the substitution of carbohydrate for fat in the diet resulted in a diminished output of thiamine in the urine. This is interpreted as indicating an increased demand for thiamine in metabolic reactions.

Relation of dietary fat level to fatty livers in several strains of mice.

FENTON, P. F., DOWLING, M., AND MERSHON, J. *J. Nat. Cancer Inst., 15,* 429-32 (1955); *Nutrition Abstr. & Revs., 25,* No. 3844 (1955).

Groups of weanling male mice of 5 strains were fed for 4 to 7 mos. on a high-fat diet contg. maize oil 5% and Crisco 45%. The mice of 4 of the strains developed fatty livers on the diet with 50% fat. One strain of mice could not be made obese and did not develop fatty livers.

Lysine and cariogenicity of two experimental rat diets.

MCCLURE, F. J., AND FOLK, F. E. *Science, 122,* 557-8 (1955).

Lysine supplementation of heat-processed cereal foods and dry autoclaved skim-milk powder inhibited the formation of smooth surface rat caries produced by these diets.

Lysine and methionine supplementation of all-vegetable diets for human adults.

HEGSTED, D. M., TRULSON, M. F., AND WHITE, H. S. *J. Nutrition, 56,* 555-75 (1955).

N intake and excretion data for young adult subjects consuming all-vegetable diets with and without supplements of lysine and methionine are presented. The essential amino acids of the diet

(Continued on page 20)

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SELECTED ABSTRACTS

(Continued from page 18)

were detd. Proteins of fruits and vegetables which are usually not considered to be of importance in protein nutrition may be an important supplement to the cereal proteins.

Serum lipid and fat tolerance studies in normal, obese and atherosclerotic subjects.

POMERANZE, J., BEINFIELD, W. H., AND CHESSIN, M. *Circulation, 10,* 742-6 (1954); *Nutrition Abstr. & Revs., 25,* No. 2267 (1955).

A fat tolerance test was made on 5 men with normal serum lipid values, 4 with abnormal serum lipid values, 6 men over 70 years old with clinically established atherosclerosis, 10 moderately obese and 11 extremely obese subjects. Blood fat after the test meal rose and remained high in obese and atherosclerotic subjects and in those with abnormally high blood cholesterol values. In the last and in those with atherosclerosis, restriction of fat resulted in marked improvement of fat tolerance; a similar improvement followed reduction in weight of extremely obese subjects.

Experiments with intermittent feeding of protein to rats.

GEIGER, E., RAWI, I. E., AND THOMAS, H. V. *J. Nutrition, 56,* 273-83 (1955).

Expts. with rats on low-caloric intake show that periodic feeding of the protein fraction does not improve the utilization. The rate of growth on such intermittent feeding is lower, even though the total protein intake for the 8-day period is the same as in the control expts. in which the protein quota was fed in equally divided daily doses. Short-term protein restriction in rats does not seem to create a specific protein hunger which would "instinctively" increase the protein intake when protein-rich diets are made available. The expts. support the view that growth and maintenance are at an optimum when the rate of protein intake closely parallels the growth and maintenance requirements of the body.

Factors affecting calcium absorption by adults.

BRINE, C. L., AND JOHNSTON, F. A. *J. Am. Dietet. Assoc., 31,* 883-8 (1955).

Among the factors reviewed, only protein and vitamin D improved Ca absorption. Several factors reduce the amt. of Ca absorbed from the diet. Phytates have this action if the diet is high in phytates and low in Ca. Oxalates interfere with absorption but only to a minor extent. The amt. of phosphate and of fat in the diet were found to have no effect on Ca absorption.

Satiety values of isocaloric diets for reducing.

FRYER, J. H., MOORE, N. S., WILLIAMS, H. H., AND YOUNG, C. M. *J. Am. Dietet. Assoc., 31,* 868-75 (1955).

Twelve overweight subjects were fed isocaloric reducing diets in which the proportions of carbohydrate, fat, and protein were varied. After a 3-wk. adaptation period to each diet, capillary and venous blood samples were obtained. There was a marked reduction in the satiety value of the diets contg. the lower protein components. No correlation was found between the capillary, venous, or Δ-glucose levels and satiety values of the diets used. No confirmation was obtained for the "glucostatic theory" of appetite regulation. It is suggested that the humoral mechanism controlling the appetite may depend on levels of individual metabolites or the over-all state of equil. on the "final common pathway" of metabolism.

Foods that do not nourish.

MITOLO, M. *J. Am. Med. Assoc., 159,* 396 (1955).

The antagonism between invertin and glucose or fructose is known, also that carbohydrates antagonize the action of vitamin B_1. Rancid fats can oxidize and destroy vitamin A, and an excess of fats decreases the antirachitic activity of a food. There are foods whose excess content of one or more vitamins can induce the deficiency of another vitamin and produce signs of hypovitaminosis or avitaminosis.

PHARMACOLOGY AND TOXICOLOGY

The toxicity of individual essential amino acids and their diastereomers in rats and the effect on blood sugar levels.

Arch. Biochem. Biophys., 58, 253-4 (1955).

The toxicity of the L- and D- forms of the 10 essential amino acids and of 2 diastereomers in rats was detd. Data on the L-forms of the amino acids are given.

PHYSIOLOGY AND MEDICINE

The physiological effects of lactose.

DUNCAN, D. L. *Nutrition Abstr. & Revs., 25,* 309-20 (1955).

A review. Discussed are lactose in the digestive tract, lactose in the body, the relation of lactose to Ca metabolism, lactose in infant feeding and its effects on the intestinal flora, and effects of an excess of lactose.

FOOD AND FOOD TECHNOLOGY

COCOA AND COCOA PRODUCTS

Soluble carbohydrates of cocoa beans.

THALER, H. *Naturwissenschaften, 41,* 432 (1954); *Nutrition Abstr. & Revs., 25,* No. 1823 (1955).

Paper chromatography of exts. of Arriba cocoa revealed the presence of 2 carbohydrates in addn. to glucose, fructose and sucrose, one a trisaccharide, the other probably a tetrasaccharide. It is suggested that these are raffinose and stachyose. Traces of a pentose and a methylpentose were also detected. The same carbohydrates were also found in a sample of cracked beans from Accra, as well as another carbohydrate, possibly a trifructose anhydride. The Arriba sample contained much glucose but hardly any fructose and the Accra one very little of either. Further studies are in progress.

COFFEE AND TEA

The role of temperature in tea brewing.

PUNNETT, P. W. *Tea & Coffee Trade J., 109,* 73-4, September (1955).

Chem. analyses and cup testing prove that brewing temp. of 180° represents dividing line between flavorful and dull tea.

Autoxidation of catechin.

HATHWAY, D. E., AND SEAKINS, J. *Nature, 176,* 218 (1955).

A mechanism is proposed for the autoxidation of catechin to a polymer catechin tannin.

DEHYDRATED AND FROZEN FOODS

The vacuum contact-plate dehydration of foodstuffs.

GOODING, E. G. B., AND ROLFE, E. *J. Sci. Food Agr., 6,* 427-33 (1955).

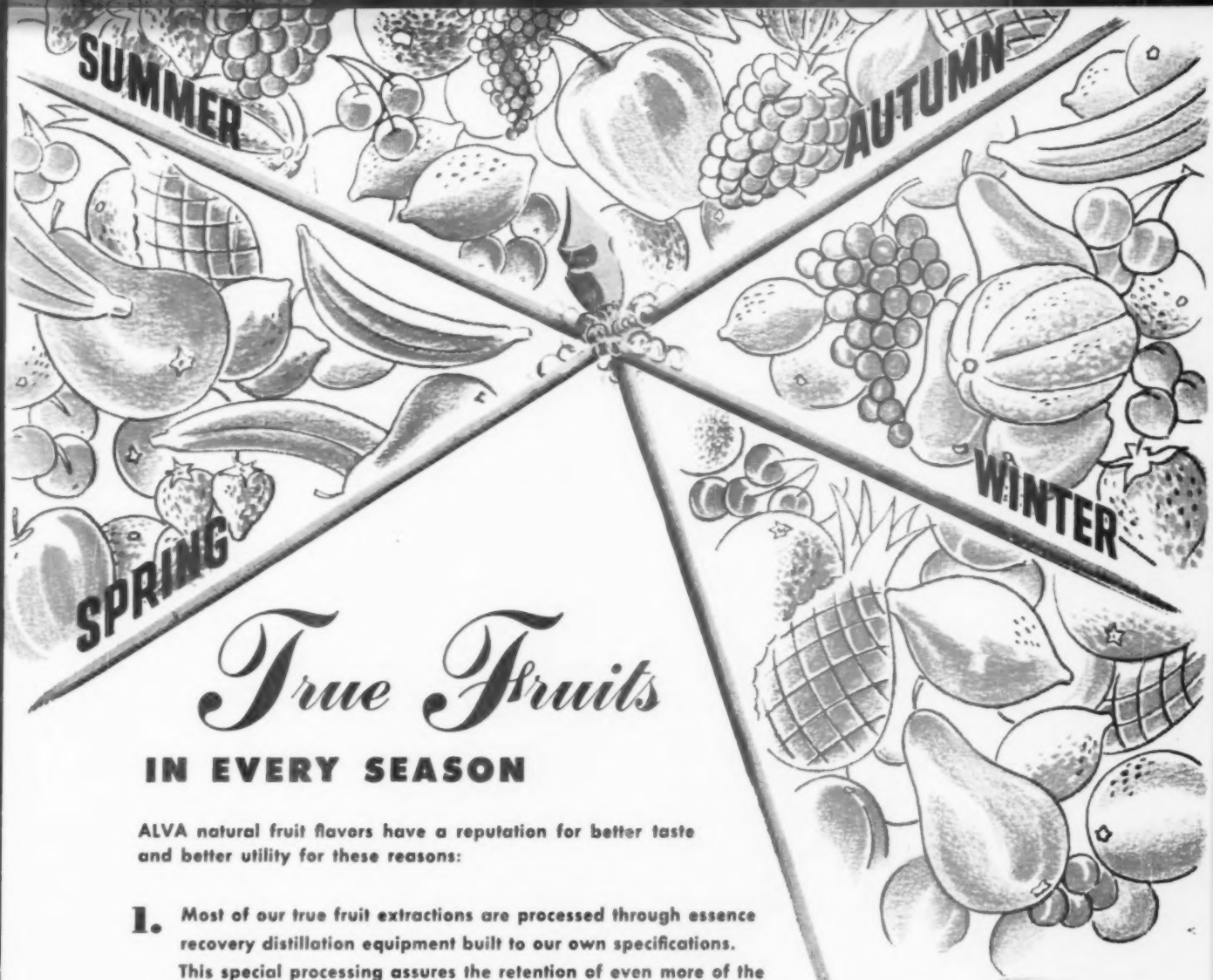
The conventional hot-air drying and the vacuum contact-plate drying methods are described and compared. The latter yields better dried products than the former, both in appearance and palatability of the reconstituted, cooked material, and there is some evidence that the storage properties are also improved. Relevant factors are the absence of oxygen and the milder heat treatment of the foodstuff during vacuum contact-plate dehydration.

FATS AND OILS

Nutritive value of heated vegetable oils.

RAJU, N. V., AND RAJAGOPALAN, R. *Nature, 176,* 613-4 (1955).

(Continued on page 24)



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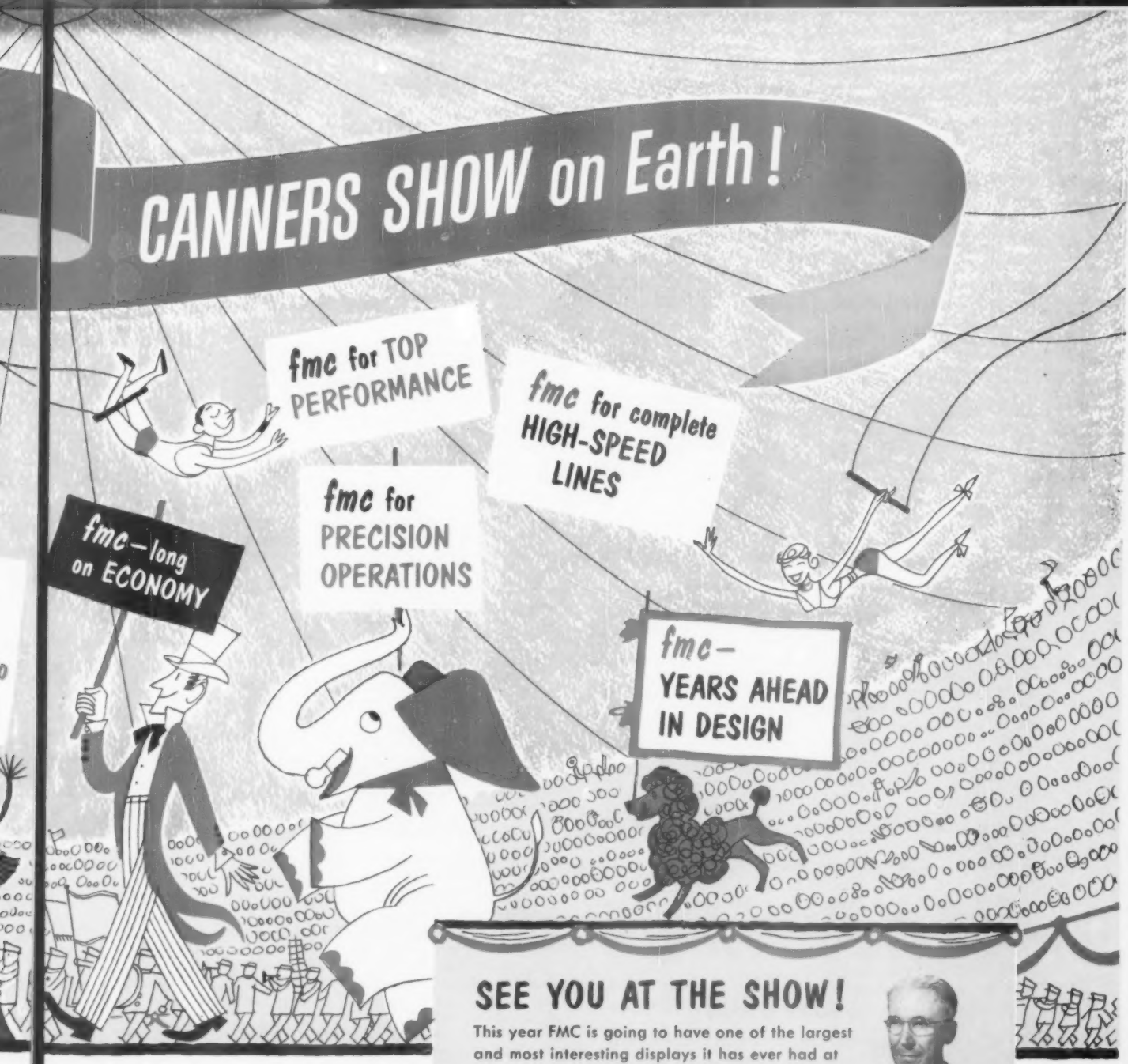
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SELECTED ABSTRACTS

(Continued from page 20)

Heated oils were shown to be poorly absorbed, to produce cancerous tumors and to cause paralysis resembling that due to vitamin E deficiency. Thermal polymerization was found to develop toxic products responsible for growth depression.

GELATIN AND GUMS

Immunochemical comparisons of various gelatins and their derivatives.

MAURER, P. H. *Arch. Biochem. Biophys., 58,* 205-13 (1955).

It was demonstrated that there is little immunochem. difference among the various gelatins derived from mammals and fish. In contrast, isinglass and sponge "gelatin" did not behave as gelatin. Results of the immunochem. behavior of the various gelatin derivs. would seem to indicate that neither the amino nor carboxyl groups of the gelatin mol. are responsible for the serological specificity of the mol.

Extraction of collagen from tissues.

FITCH, S. M., HARKNESS, M., AND HARKNESS, R. *Nature, 176,* 163 (1955).

The use of trichloroacetic acid to ext. collagen from tissues is outlined.

Ionotropic gels of polyuronic acids.

THIELE, H., AND ANDERSEN, G. *Kolloid Z., 143,* 21-31 (1955).

Comparisons between ionotropic and biological gel structures reveal no basic differences in structure or behavior. Alginic acid can be located in tissue because it shows double refraction. In analogy to pectic substances of higher plants it is found in the middle lamella and the primary membranes of the *phaeophyceae*. Nucleic acid gels were obtained at as low as 0.07% concns. in the presence of 0.3 molar divalent ions.

LEGISLATION

Chemical additives and the federal food, drug, and cosmetic act.

LARRICK, G. P. *Food, Drug Cosmetic Law Repts., 10,* 432-40 (1955).

The Commissioner of food and drugs, addressing the annual meeting of the Institute of Food Technologists, at Columbus, Ohio, on June 14, said that consideration of any additive must take into account the total intake of the additive and related substances from all sources.

MILK AND MILK PRODUCTS

The effect on flavor of using substitute fats in dry whole milk.

HERALD, C. T., AND PATTON, S. *J. Dairy Sci., 38,* 640-4 (1955).

Vacuum packed dry milk made with coconut oil had good flavor after 6 mos. storage at rm. temp. Cottonseed, soybean and peanut oils and lard used in place of milk fat give samples with poor flavor (oxidized). Dry whole milk develops during storage a stale flavor different from an oxidized flavor.

POTATOES

Flavor tests on potatoes grown in soil where lindane was applied to cucumbers.

KIRKPATRICK, M. E., LINTON, G. S., MOUNTJOY, B. M., AND ALBRIGHT, C. W. *Am. Potato J., 32,* 259-64 (1955).

Foliage applications of lindane may be a potential source of off-flavor both in current seasons crop and to those subsequently grown with the same treatment.

SUGARS AND SIRUPS

Brighter carbohydrates.

British Patent 733,860. *Food Manufacture, 30,* 351-4 (1955).

Addition of a blue fluorescing substance to whiten carbohydrates is discussed. The materials are similar in function to "optical bleaches" used in soaps. They are coumarin derivs. said to be non-toxic at 0.001-0.5% by wt. of flour, sugar, etc. Compn. examples include 7-ethylamino-coumarin.

PHYSICAL RESEARCH

The hydrogen bond.

WARD, A. G. *Brit. Gelatine Glue Research Assoc. Abstr., 6,* 1-10, May (1955).

A literature review of the H bond is presented with particular reference to H bonding in aq. and alc. soln. Also discussed is the role of H bonds in proteins.

Charge and stability of colloids.

CHATTERJI, A. C., AND TEWARI, P. *Kolloid Z., 143,* 32-5 (1955).

Effect of non-electrolytes like methyl alcohol, ethyl, *n*-propyl, *n*-butyl, *n*-hexyl alcohols, glucose, sucrose, urea, starch and isoelectric gelatin on negatively charged selenium oxide sol. was studied by Spekker absorptiometer in presence of $BaCl_2$ as coagulating electrolyte. It was observed that the substances studied generally stabilize the sol. except ethyl alcohol in all concns., methyl and *n*-propyl alcohols in high concns. which have been found to sensitize it. It was found that dielectric constant does not explain completely the phenomenon of sensitization and protection.

Rheological aspects of water-in-oil emulsions.

SHERMAN, P. *Mfg. Chemist, 26,* 306-10 (1955).

This article is concerned with water-in-oil emulsions which, above a certain limit of concn., exhibit an increase in viscosity and plasticity and an alteration in flow properties. The factors which influence the viscosity, yield value and stability of emulsions exhibiting plasticity are considered.

ORGANIC CHEMISTRY

Aldolization, ketolization, and crotonization: catalysis with anion-exchangers.

AUSTERWEIL, G. V., AND PALLAUD, R. *J. Appl. Chem., 5,* 213-15 (1955).

The aldolization of aldehydes, catalyzed by anionic exchangers, can be extended to a similar reaction in which aldehydes react with ketones. By using strongly basic anion exchangers the reaction proceeds a step further in the condensation process through loss of H_2O to give olefinic aldehydes by crotonization.

MISCELLANEOUS INFORMATION

Technic for preparing hand-drawn lantern slides.

FAIRHALL, A. *J. Chem. Educ., 32,* 435 (1955).

There are available materials for making slides called typewriter slides, using transparent plastic sheets and C-paper. Ordinarily the ink will not adhere to the plastic film (e.g., polystyrene). To overcome this difficulty, it is recommended to swab the sheet with alc. contg. 2% acetone. Erasures may be made and various colored inks employed to emphasize particular features.

Information transfer in the living cell.

GAMOW, *G. Sci. American, 193,* 70-9 (1955).

By comparing components of genetic material to playing card suits, the author suggests how cells store their identities in the form of chem. codes which they use to build replicas of themselves.

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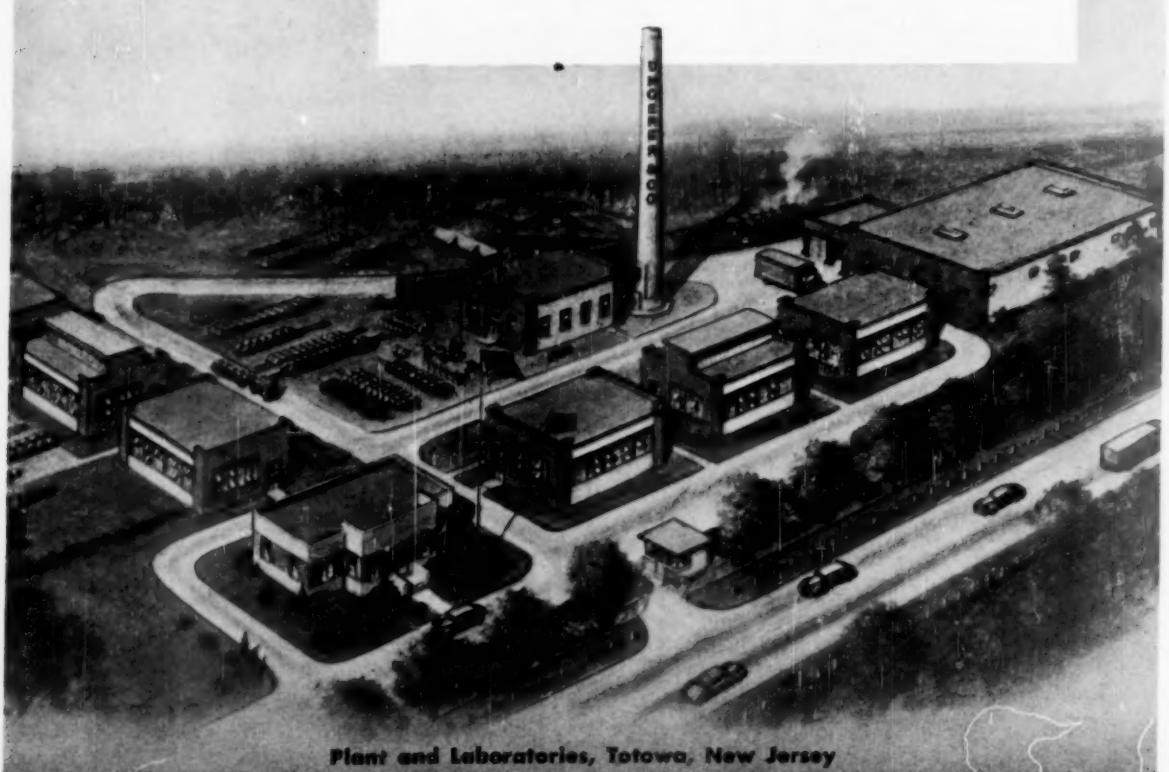

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Dehydrated Pork Studies: Removal of Glucose by Glucose-oxidase Enzyme[a, b]

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(Manuscript received March 21, 1955)

Glucose-oxidase enzyme was used with food grade hydrogen peroxide to prepare dehydrated pork of reduced glucose content. The available glucose was oxidized to gluconic acid. Meat particles of a ⅛ inch grind were best suited for this type of reaction and yielded a finished product with an extended shelf life. Four milliliters of liquid enzyme and 5 ml. of peroxide (30%) were added to each 1000 g. of meat. The optimum reaction time was 4 hours at 13° C. (55° F.). Reacting the meat more than 4 hours with the enzyme did not improve its shelf life. Nearly 25% more of the glucose was converted to gluconic acid when cooked pork was reacted with the enzyme as compared to that which was uncooked. The taste panel found the enzyme-treated meat superior to the control.

Dehydrated foodstuffs are subject to discoloration and loss of flavor during high temperature storage. This condition results from a reaction between amino and free aldehyde groups, Hodge *(6)*. In meat, glucose or its breakdown products are the sources of free acting aldehyde groups. Control of browning in eggs has been achieved by removing these reducing groups. According to Hawthorne and Brooks *(4)*, egg albumen contains 0.5% glucose. Lean muscle tissue contains traces of sugar (glucose) and glycogen, Bull *(2)*. Winton *(11)* pointed out that the sugar and glycogen levels in muscles at the time of slaughter were dependent on the metabolic condition of the animal. He further stated that the dextrose content of beef muscle varied from 0.01 to 0.25%; whereas, in horse meat it varied from 0.14 to 0.42%. According to Williams *(10)*, reducing substances in fish varied with the species, i.e. 0.04% for smelt and 5.16% for salmon.

In previous work *(5)* it has been shown that fresh lean pork contained less than 0.2% glucose. Furthermore, *Saccharomyces cerevisiae*, metabolizing in the presence of raw and cooked meat, reduced the glucose content 50 and 75%, respectively. The size of the meat particle was found to influence the amount of glucose removed. Also, the quantity of glucose removed was some function of its rate of release from the meat fibers. Particles of ⅛ inch grind were the most satisfactory for yeast fermentation when based on the quantity of glucose removed, product texture, color, and flavor.

In 1953, Carlin and Ayres *(3)* reported that a glucose oxidase-catalase enzyme system could be used to remove glucose from egg white prior to drying. Scott *(8)* reported, that yolk and whole egg can be desugared by means of this enzyme system, and Baldwin *et al. (1)* stated, that this method has been successfully used in commercial operations. Snyder *(9)* recommended, that 3 pounds of liquid enzyme be used to desugar 1,000 pounds of yolk or whole eggs. The time required to reduce effectively the glucose level was 3½ hours at a contact temperature of 38° C. (100° F.).

The principal objective of this investigation was to determine the optimum conditions for the removal of glucose from pork by glucose oxidase-catalase, and thus improve the shelf life of dehydrated pork.

EXPERIMENTAL

Two hundred and fifty pounds of lean meat were prepared from fresh hams by removing the skin, fat, and bones. The lean (95%) was ground through a ½ inch plate then reground through the ⅛ inch plate, packaged in Marathon Tite and held at 18° C. (0° F.) until used. Two thousand gram lots were used for each treatment and dehydration.

A liquid preparation of glucose oxidase and catalase was used to convert the glucose to gluconic acid. This enzyme preparation[g] contained 180 units per ml., and was a clear, stable, amber solution readily miscible with water. One unit of enzyme is defined by Sarett *(7)* as that amount which will cause an oxygen uptake of 10 cu. mm. per minute.

The quantity of enzyme used for each treatment was diluted to 100 ml. with distilled water. This larger volume of dilute enzyme solution was then uniformly mixed with the ground pork while being added from a buret during the reaction period. The temperature during the reaction time was maintained at 13° C. (55° F.). Five ml. of 30% hydrogen peroxide were used per 100 g. of meat. The hydrogen peroxide was diluted 100 ml. to secure a more uniform distribution throughout the meat. Approximately 25% of the peroxide was added during the first 5 to 10 minutes and the remainder added drop by drop in order to compensate for the oxygen loss.

The treatments were as follows: (a) Control: the meat was ground through a ½ inch plate, cooked in a steam jacketed kettle, then ground through a ⅛ inch plate, and dehydrated. (b) Raw meat of ⅛ inch grind was made into a slurry with distilled water, treated with various amounts of enzyme per 1000 g. of meat for different time intervals at 13° C. (55° F.),

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[f] Associate Professor of Botany.

[g] Enzyme supplied by the Takamine Laboratories Inc., Clifton, New Jersey.

followed by cooking, and dehydration. (c) Meat particles (⅛ inch) were cooked sufficiently to coagulate the proteins, made into a slurry with water, treated with 4 ml. of enzyme per 1000 g. of meat for 6 hours at 13° C. (55° F.), followed by cooking as in treatment (a) and (b), and then dehydrated. (d) Raw meat of ⅛ inch grind was made into a slurry with distilled water, treated with 4 ml. of enzyme per 1000 g. of meat for 6 hours at 13° C. (55° F.), followed by cooking, then reground and dehydrated. The meat slurry was mechanically agitated throughout the enzyme treatment period. When raw meat was used, it was noted that pieces of fat and lean would cling to the stirring paddles and reduce the effectiveness of mixing.

The enzyme treated and control pork were cooked to drive off the excess moisture and then vacuum dried. Two-hundred gram samples of the cooked meat were placed in aluminum trays (5 x 4 x 2 in.), and dehydrated at 65° C. (149° F.) under 26 inches of vacuum for periods up to 12 hours. The moisture content was reduced to 4% or less during drying. A portion of each dried sample was scored by the taste panel. The remainder was vacuum-packed in glass jars, stored at 49° C. (120° F.) for 2 months, then rescored.

The method used for determining the glucose content has been previously reported *(5)*.

RESULTS AND DISCUSSION

Data in Tables 1, 2, and 3 refer to meat prepared as in treatment a and b, while data in Table 4 refer to each treatment.

The taste panel evaluation of the glucose oxidase-catalase enzyme treated pork is given in Table 1. When 6 ml. of enzyme per 1000 g. of meat were used, a medicinal flavor was detected in the unstored dehydrated pork. However, this same flavor was not detected after 2 months' storage at 120° F. The most palatable stored product was obtained with 4 ml. of liquid enzyme per 1000 g. of meat. This amount of enzyme converted 53% of the available glucose to gluconic acid, and the product browned only slightly during storage. From the standpoint of glucose removal and product desirability, there

TABLE 1

Taste panel evaluation and glucose content of enzyme-treated dehydrated pork

Enzyme ml./1000 g. of meat	Browning score [1]		Glucose percent
	Unstored	Stored	
Control	6.8	2.7	0.190
0.5	6.6	3.1	0.120
1.0	6.5	3.6	0.118
2.0	6.2	4.2	0.099
4.0	6.0	6.3	0.091
6.0	5.8	6.1	0.089

[1] Mean value for browning determined by five judges. A score of 7 indicated the most palatable sample and the least amount of brown flavor. Meat particles were ⅛ inch grind. The reaction period for each added enzyme level was 6 hours at 13° C.

was no advantage in using larger amounts of enzyme (6 to 8 ml.). With lesser amounts (1 to 2 ml.), the product browned more during storage due to the higher glucose content. The quantity of glucose removed from the ground pork was influenced by the meat particle size, amount of enzyme, reaction time, and the available oxygen. With meat particles of ⅛ inch grind, the glucose content was reduced from 35 to 54%, depending on the enzyme concentration used.

It will be noted from Table 2 that when 4 ml. of enzyme were added to 1000 g. of meat, that most of the glucose was oxidized during the first 2 hours of the reaction period. A small additional amount of glucose was removed by allowing the enzyme to react for 4 hours. Reacting the meat and enzyme for 6 hours improved the flavor characteristics, but the glucose content

TABLE 2

Effect of the reaction period on the oxidation of glucose and palatability of stored and unstored dehydrated pork

Reaction period hours	Browning score [1]		Glucose [2] percent
	Unstored	Stored	
Control	5.0	1.8	0.192±.004
0.5	5.1	2.8	0.111±.005
1.0	4.6	2.6	0.102±.001
2.0	5.2	3.6	0.094±.004
4.0	6.2	3.7	0.091±.004
6.0	6.4	4.0	0.091±.006

[1] Samples stored at 120° F. for 2 months. A score of 7 was the most desirable.

[2] Mean value and standard error of the mean for unstored meat particles of ⅛ inch grind. The enzyme level for each reaction period was 4 ml. per 1000 g. of meat at a temperature of 13° C.

remained unchanged. The dehydrated pork which was treated for 4 hours with 4 ml. of enzyme and then stored, was superior in flavor, texture, and appearance compared with the control. As noted in Table 3, the influence of storage period was more significant than the enzyme-meat reaction period in causing browning.

TABLE 3

Analysis of variance of taste panel data for enzyme-treated stored pork

	D/f	S.S.	M.S.	F-Value
Enzyme-Meat Reaction Period	5	0.45	0.11	9.16*
Storage	1	1.65	1.65	137.50**
Error	5	0.06	0.012	
Total	11	2.25	0.204	

*Significant at the .05 level.
**Significant at the .01 level.

Particles of ½ inch grind required a longer reaction period to remove the glucose than those of ⅛ inch grind.

In those cases where the raw meat was treated with the enzyme, fat and lean collected on the stirring paddles. This caused the meat to clump and resulted in a dehydrated product of large aggregates. The texture of these samples after dehydration was undesirable, and the flavor was bland. A slight amount of brown color was noted in this stored enzyme treated meat, although the glucose content was reduced 54%. The treated stored dehydrated pork was superior to the control in flavor and color; however, the texture was considered undesirable.

Cooking the meat (treatment c) prior to adding the enzyme yielded a more desirable product than that prepared from raw meat enzyme treated (b and d). (Table 4.) Approximately 75% of the glucose was removed by this method of preparation compared to 54% removed from the meat treated raw. The cooked meat enzyme treated did not develop a brown color or flavor during the 2 months' storage period at 120° F. and the texture was considered

good; whereas, raw meat enzyme-treated (treatment d) was not as palatable as the other enzyme prepared samples (Table 4). The texture of this product was undesirable due to surface browning. Apparently grinding the meat after it had been enzyme-treated, exposed some of the meat which contained unconverted glucose, causing it to brown during storage. The flavor of the meat prepared in this manner was described by the taste panel as being *slightly brown*. (Treatment d.)

TABLE 4

Taste panel evaluation of dehydrated pork with various treatments [1]

Treatments	Score			Aroma	Flavor
	Unstored	Stored [2]			
	Composite	Composite	Appearance		
(a) Control	6.7	2.7	3.0	3.0	2.8
(b) Raw	6.6	5.8	6.0	5.6	6.0
(c) Cooked	6.8	6.7	6.8	6.4	6.8
(d) Raw and Reground	6.7	5.1	6.2	4.4	4.8

[1] Particles of ⅛ inch grind treated with 4 ml. of enzyme per 1000 g. of meat. Product was held at 13° C. for 6 hours. Data are the average value of two separate lots rated by 5 judges.

[2] Stored under vacuum for 2 months at 120° F.

SUMMARY AND CONCLUSIONS

Dehydrated pork of lowered glucose content was prepared by oxidizing the available glucose to gluconic acid. The glucose oxidase-catalase enzyme system was used with food grade hydrogen peroxide. Both raw and cooked meat treated with 4 ml. of enzyme per 1000 g. yielded a desirable dehydrated product. Reaction periods ranging from ½ to 6 hours were studied. An enzyme-meat reaction period as short as 4 hours resulted in a product with improved shelf life. Longer periods did not improve the product. Approximately ½ of the glucose was converted to gluconic acid in 4 hours when raw meat particles of ⅛ inch grind were used.

Cooked pork of ⅛ inch grind treated with the glucose oxidase-catalase enzyme system produced a more stable product than that prepared from raw pork. Approximately 75% of the glucose in cooked meat was oxidized by the enzyme. This product browned only slightly during storage and the flavor was more desirable than those samples prepared from meat which was treated raw.

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Effect of Heat Treatment of Musts on the Color Characteristics of Red Wine

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High temperature, short time processing treatment was applied experimentally to wine production. Changes in the organoleptic characteristics of the wines, particularly color stability, were followed during aging for periods of 16 to 55 months.

In the production of red wines the extraction of sufficient color from the grapes to produce adequately colored wines has always presented a problem. With the exception of a few varieties which have colored pulp the pigments are found entirely in cells in the skins. To effect color release to the juice it is necessary that the cells he made permeable to the passage of the pigment. Thus, the degree of color attained by the juice of a given grape variety is dependent upon the temperature and amount of alcohol present, both of which affect the cell permeability, and the contact time of the juice with the skins. Where the alcohol content is low and the contact time short, as in the production of port wines, well-colored wines are rarely produced unless the must (skins, seeds, pulp and juice) is heated.

The basic method for extracting color has been intermittent pumping of the juice over the floating pomace (skins, seeds and pulp) during the course of the fermentation. Berg *(1)* has reviewed the numerous process modifications; most of which entail heating the must to temperatures of 38° C. to 60° C., pumping over for a period of several hours, and then cooling to fermentation temperature. These practices produce more deeply colored juices, but usually have an unfavorable effect on the quality of the resultant wine.

High temperature, short time processing treatments in the canning industry have been found to do the least damage to the quality of the treated products. It was felt that this might be equally true in wine production. Accordingly six lots of wine were produced by this method during the period 1949 to 1951. Changes in the organoleptic characteristics of the wines, particularly the color stability, were followed during aging for a period of 16 to 55 months.

EXPERIMENTAL

The grapes were processed in commercial wineries using plant equipment. Sample lots of 1 to 5 gallons obtained from the plant processing were fermented in glass in the Enology Cellars at Davis.

Equipment. The crushers used were the conventional paddle- and screen-type equipped with stem separators. Berg and Marsh *(2, 3)* and Overby *(6)* have described in detail the heat processing equipment which consisted of a large paddle-equipped mixing tank, a tube in tube heat exchanger and steam chest, and a holding tank of sufficient size to allow a holding period of 2 minutes at the desired temperature. The press used was a continuous, screw type which produced a juice with a high content of finely divided particles of skin and pulp.

Must treatment. The grapes were crushed, pumped to the mixing tank, and, after thorough agitation, pumped through the heat exchanger and holding tank. The sample lots were collected from either the inlet or outlet of the heat exchanger.

When juice was fermented "off skins," the separation from the pomace was made by screening prior to fermentation. In fermentations "on skins," the wine was drawn from the pomace at the end of the fermentation. Press juice was obtained by screening the juice from the pomace immediately following the heat treatment, then pressing the pomace in the screw-type press. Where Pectinol O[a] was used it was added in the form of a powder prior to fermentation.

Approximately 100 p.p.m. of sulfur dioxide followed several hours later by a 1% culture of Montrachet yeast strain was added to each sample lot. Fermentations were conducted at approximately 20° C. with twice daily agitation of the lots fermenting on the pomace. Wine used in the production of port was withdrawn from the fermentation container and fortified to 20% alcohol when approximately half the sugar had been fermented. The dry wines were not drawn from the pomace until nearly all the sugar had disappeared.

Wine treatment. Following completion of the fermentations the wines were placed in glass jugs and periodically racked until they became clear. The only additional treatment was that given the 1949 dry reds and ports which were clarified with Bentonite[a] as they failed to clear naturally. When the wines became clear they were given a final racking, bottled, and stored at 12.8° C.

Taste testing. The wines were tasted at intervals by three experienced wine tasters. Samples were presented in coded glasses to assure an impartial judgment. A numerical score was used to indicate the relative quality of the wines.

Color determination. At periodic intervals samples were removed from the cellar for transmission measurements on the Coleman Model 11 spectrophotometer. All samples were filtered through diatomaceous earth prior to the measurement. The percent transmission was determined at 25 mμ intervals over the range of 400 to 700 mμ using a 2 mm. cuvette with water as the reference liquid. The dominant wave length, percent purity and percent brightness were determined from the transmission values[b] using the weighted ordinate method of Hardy *(5)*. The color difference, ΔC, between samples was determined in McAdam units from the trichromatic coefficients and brightness values, using the nomographs based on Davidson's *(4)* calculations. A McAdam unit is proportional to the minimum perceptible difference between two colors ase judged by the average observer, and is derived from graphical measurements of the distance between points on the surface of McAdam ellipsoids.

RESULTS AND DISCUSSION

The factors investigated were temperature of heat treatment, fermentation on and off the skins, retention

[a] The mention of commercial products is not to be construed as an endorsement by the University of California (or by this journal) over other products of similar nature not mentioned.

[b] Because of the color density of the samples the transmission measurements were made through a 2 mm. depth instead of a 50 mm. depth through which wine is usually observed. The color characteristics reported thus directly reflect the appearance of the 2 mm. sample. However, the appearance of the 50 mm. sample would differ only quantitatively from that of the 2 mm.

TABLE 1
Must treatment

Sample no.	Unheated	Heated °C.	Fermented	
			on skins	off skins
1949 Dry Red[1]				
1	x		x	
2		65.6	x	
3		76.7	x	
4		90.0	x	
1949 Port[2]				
2	x		x	
3		66.7	x	
4		76.7	x	
5		90.0	x	
1950 Dry Red[3]				
B-1		79.4		x
B-2		85.0		x
B-3		90.6		x

[1] 9.4% Zinfandel, 90.6% Carignane grapes.
[2] 54.5% Carignane, 31.4% Grenache, 14.1% Alicante Bouschet grapes.
[3] 21.1% Zinfandel, 72.5% Carignane, 6.4% Alicante Bouschet grapes.

time on skins, pressing, and Pectinol. Tables 1-15 give the must treatments and their effect on the color characteristics of the resultant wines.

Effect of temperature. The temperatures to which the musts were heated are given in Table 1. Reference to Table 2 shows a pronounced decrease in redness with increasing must treatment temperatures in the 1949 Dry Red wines. With continued aging all the wines became less red until at the end of 41 months there was little difference in hue. The brightness values show a large increase in color density[c] with increased treatment temperature. The values given in Table 3 substantiate this large difference and show it was maintained throughout the aging period.

[c] Increase in color density as used here is indicative of an increase in pigmentation. Normally an increase in color density can be considered to indicate a decrease in brightness and an increase in saturation, although it may or may not be accompanied by a change in dominant wavelength.

TABLE 2
Color characteristics of the musts and wines

Sample	Dominant Wavelength					% Purity (Degree Saturation)					% Y (Brightness)				
1949 Dry Red[1]															
	2[4]	6	20	30	41	2	6	20	30	41	2	6	20	30	41
1	700	635	598	610	606	25.0	21.0	25.8	23.0	26.0	33.2	38.6	44.1	38.2	37.0
2	645	632	604	606	604	35.0	27.5	31.0	31.5	33.0	24.3	29.4	34.1	31.9	31.8
3	630	627	603	618	610	45.5	42.0	38.5	47.0	42.8	16.1	17.0	25.3	14.0	21.1
4	625	626	608	616	613	50.0	46.5	37.3	45.0	42.0	14.2	15.7	21.1	16.5	19.3
1949 Port[2]															
	2[4]	6	20	30	41	2	6	20	30	41	2	6	20	30	41
2	609	604	596	593	589	23.0	29.5	33.0	35.0	27.0	42.3	37.9	39.2	42.7	54.6
3	611	604	596	594	592	23.5	31.5	39.2	41.5	39.0	40.6	36.1	33.4	35.7	40.1
4	608	603	593	594	593	23.5	32.0	38.0	39.5	38.8	40.3	34.8	39.5	36.3	37.4
5	610	603	595	594	592	30.3	35.5	38.0	39.0	36.5	32.6	30.9	36.3	36.8	42.3
1950 Dry Red[3]															
	0[4]	2	8	18	29	55	0	2	8	18	29	55	0	2	8	18	29	55
B-1	621	624	625	620	609	602	55.5	38.0	34.0	33.5	31.5	27.2	13.3	22.7	24.3	25.5	32.1	37.4
B-2	630	624	623	617	606	599	57.0	34.0	35.0	37.0	32.3	27.0	13.7	22.4	24.1	22.8	33.5	40.4
B-3	621	618	620	616	607	596	57.0	41.0	38.0	45.0	30.0	26.0	13.0	20.4	22.3	18.9	34.8	45.3

[1] See Table 1, footnote 1.
[2] See Table 1, footnote 2.
[3] See Table 1, footnote 3.
[4] Numbers heading columns refer to number of months following crushing. If number is 0 it denotes unfermented juice immediately after heat treatment.

TABLE 3
Color differences in McAdam units

Comparison	ΔC				
1949 Dry Red[1]					
	2[4]	6	20	30	41
1:2	24.6	16.2	16.3	14.0	12.2
1:3	40.5	58.7	32.5	61.2	41.1
1:4	45.0	73.7	40.0	53.1	44.5
1949 Port[2]					
	2[4]	6	20	30	41
2:3	2.8	3.4	11.1	12.5	21.9
2:4	0.3	4.6	5.0	9.0	24.4
2:5	17.5	12.1	6.0	9.0	17.0
1950 Dry Red[3]					
	0[4]	2	8	18	29	55
B-1:B-2	12.8	6.5	6.9	6.6	3.1	4.2
B-3:B-3	2.2	3.8	6.9	25.0	6.2	11.5

[1] See Table 1, footnote 1.
[2] See Table 1, footnote 2.
[3] See Table 1, footnote 3.
[4] See Table 2, footnote 4.

TABLE 4
Must treatment

Sample no.	Unheated	Heated °C.	Fermented	
			on skins	off skins
1950 Dry Red[3]				
A-1	x		x	
B-2		85.0		x
1951 Dry Red[5]				
3	x		x	
4		87.8		x
1950 Port[6]				
50-1	x		x	
50-2		85.0		x
1950 Port[7]				
B-1	x		x	
B-2		85.0		x

[3] See Table 1, footnote 3.
[5] 100% Carignane grapes.
[6] Malvoisie, Alicante Bouschet.
[7] Carignane, Grenache, Mission.

TABLE 5
Color characteristics of the wines

Sample	Dominant Wavelength					% Purity (Degree Saturation)					% Y (Brightness)				
	1950 Dry Red[2]														
	2[3]	8	18	29	55	2	8	18	29	55	2	8	18	29	55
A-1	631	630	634	608	599	38.0	31.5	30.0	38.0	29.5	23.7	22.9	27.2	26.3	36.4
B-2	625	623	617	606	599	34.0	35.0	37.0	32.3	27.0	26.4	24.1	22.8	33.5	40.4
	1951 Dry Red[2]														
	2[4]	6				2	6				2	6			
3	700	700				34.5	33.5				24.7	22.0			
4	700	700				36.0	35.0				22.8	21.9			
	1950 Port[6]														
	9[4]	18	28	54		9	18	28	54		9	18	28	54	
50-1	595	610	606	589		37.0	23.0	24.0	23.4		29.4	36.5	37.4	55.4	
50-2	600	598	597	585		26.4	27.5	30.0	25.0		42.5	41.3	40.3	61.9	
	1950 Port[7]														
	9[4]	18	28	54		9	18	28	54		9	18	28	54	
B-1	599	605	602	595		24.5	23.0	23.4	24.0		48.2	44.7	44.7	47.7	
B-2	602	605	602	600		24.0	23.0	23.8	19.8		44.7	42.7	41.8	44.1	

[2] See Table 1, footnote 3.
[4] See Table 2, footnote 4.
[5] See Table 4, footnote 5.
[6] See Table 4, footnote 6.
[7] See Table 4, footnote 7.

TABLE 6
Color differences in McAdam units

Comparison	ΔC				
	1950 Dry Red[2]				
	2[4]	8	18	29	55
A-1:B-2	13.7	5.1	10.0	17.8	5.7
	1951 Dry Red[5]				
	2[4]		6		
3:4	5.4		3.3		
	1950 Port[6]				
	9[4]	18	28	54	
50-1:50-2	10.1	8.7	7.5	5.0	
	1950 Port[7]				
	9[4]	18	28	54	
B-1:B-2	4.7	1.6	2.9	4.9	

[2] See Table 1, footnote 3.
[4] See Table 2, footnote 4.
[5] See Table 4, footnote 5.
[6] See Table 4, footnote 6.
[7] See Table 4, footnote 7.

TABLE 7
Must treatment[1]

Sample no.	Time on skins Hours
1949 Port[8]	
7	0.25
5	72.00
1951 Dry Red[8]	
4	0.25
5	0.58
6	1.12
7	2.00
8	5.00
9	10.00
10	24.00

[1] See Table 1, footnote 1.
[8] See Table 4, footnote 5.
[9] 1949 Port musts heated to 90.0° C., 1951 Dry Red musts to 87.8° C.

TABLE 8
Color characteristics of the musts and wines

Sample	Dominant Wavelength					% Purity (Degree Saturation)					% Y (Brightness)				
	1949 Port[1]														
	2[3]	6	20	30	41	2	6	20	30	41	2	6	20	30	41
7	606	601	593	596	595	29.0	36.0	40.0	40.5	41.0	36.5	33.9	36.5	33.3	35.2
5	610	603	595	594	592	30.3	35.5	38.0	39.0	36.5	32.6	30.9	36.3	36.8	42.3
	1951 Dry Red[5]														
	0[4]	2	6	16		0	2	6	16		0	2	6	16	
4	631	700	700	608		53.5	36.0	35.0	34.5		11.0	22.8	21.9	30.3	
5	624	642	665	620		57.5	38.0	37.0	30.6		11.0	22.0	21.0	29.6	
6	624	645	675	620		57.5	38.0	35.5	30.6		11.1	23.0	22.0	29.2	
7	630	640	650	624		52.5	38.5	37.0	31.0		12.1	23.2	21.5	27.9	
8	628	650	690	620		53.5	34.5	36.0	31.0		11.9	23.5	20.9	29.1	
4	630	650	690	617		51.0	37.2	36.0	32.3		12.4	23.6	21.8	28.9	
10	628	645	650	620		50.4	38.0	37.0	32.5		13.2	22.9	21.0	27.8	

[1] See Table 1, footnote 1.
[3] See Table 1, footnote 4.
[4] See Table 4, footnote 5.

The 1949 Ports exhibited a significant lessening in the red hue (a decrease in dominant wavelength) with aging, but with only a small difference due to the must treatment. An appreciable increase in color density was obtained by the heat treatment. The 1950 Ports showed the same shift in hue as the 1949 Dry Reds. The color density of the 1950 Ports decreased with increased treatment temperatures.

TABLE 9

Color differences in McAdam units

Comparison	ΔC				
	1949 Port[1]				
	2[2]	6	20	30	41
7:5	8.6	4.2	3.4	6.9	13.2
	1951 Dry Red[3]				
	0[4]	2	6	16	
4:5	4.4	3.9	4.4	6.9	
4:6	4.1	2.5	1.3	8.0	
4:7	3.9	2.6	5.0	10.3	
4:8	2.8	2.1	3.0	7.1	
4:9	7.1	1.8	2.8	7.2	
4:10	9.9	2.2	4.4	10.0	

[1] See Table 1, footnote 1.
[2] See Table 2, footnote 4.
[3] See Table 4, footnote 5.

In taste tests the wines from the heated musts fermented on the skins were found to be definitely inferior to the unheated, with a progressive decrease in quality with increasing temperature. No difference in quality was found in the 1950 Dry Reds which were fermented off the skins.

Comparison of unheated musts fermented on the skins with heated musts fermented off the skins. Table 4 gives the must treatment. As seen in Table 5 there is little difference in hue between the wines from unheated musts fermented on the skins and those from heated musts fermented off the skins. With continued aging all the wines, with the exception of the 1951 Dry Red, showed the same progressive decrease in redness. In Table 6 the difference in color ranged from appreciable to barely distinguishable. With the exception of the first lot of Port the color density of the heat treated wines was approximately the same or slightly greater than that of the control wines, though the behavior of the 1950 Dry Red was erratic. The heat treatment had no appreciable effect on the quality of the wines.

TABLE 10

Must treatment[a]

Sample no.	Free run	Press
B-2	x	
B-4		x

[a] 1950 Dry Red—musts heated to 85° C.

Effect of retention time on skins of heated musts. Table 7 gives the length of time the juice was in contact with the skins, with periodic agitation, prior to screening. As shown in Table 8 contact time had little effect on the hue. However, Tables 8 and 9 show that in the case of the 1949 Port a contact time of 72 hours during which fermentation occurred resulted in a lessening of the color density. With the 1951 Dry Red a contact time of .58 hours to 24 without fermentation gave an appreciable increase in color density. Little increase is obtained beyond 0.58 hours. The decrease in pigment content of the 72 hour Port sample may be due to the length of time on the skins, the fermentation which occurred, or to both. There was no difference in taste as a result of treatment differences.

Comparison of press wine with free run wine from heated musts fermented off skins. Table 10 gives the must treatment of the free run and press samples. There was little difference in the hue of the two lots. However, as shown in Tables 11 and 12, there was a definite difference in color density. The press wine was much darker at 2 months, lighter from 8 to 29 months, and appreciably lighter at 55 months. The press wine was greatly inferior in quality to the free run.

Effect of Pectinol O[a]. It was found that with heat treated musts the wines failed to clear well unless pectic enzymes were added prior to fermentation. It was also thought that pectic enzymes might aid in color extraction during the fermentation of unheated musts. Table 13 gives the details of the treatments designed to determine the effect during fermentation of Pectinol O. Tables 14 and 15 show the effect on the color characteristics.

In the 1950 Dry Red series both the unheated fermentations on the skins and the heated fermentations off the skins show a gradual small decrease in the red hue with increasing amounts of Pectinol. This is most evident at the end of the 55 month aging period. They also show a decrease in color density with increasing quantities of Pectinol.

At the end of the 54-month aging period one lot of Port shows a gradual small increase in redness with increasing amounts of Pectinol while the reaction of the second lot is erratic. The first lot of Port shows a

TABLE 11

Color characteristics of the musts and wines

Sample	Dominant Wavelength						% Purity (Degree Saturation)						% Y (Brightness)					
	1950 Dry Red[3]																	
	0[4]	2	8	18	29	55	0	2	8	18	29	55	0	2	8	18	29	55
B-2	630	624	623	617	606	599	57.0	34.0	35.0	37.0	32.3	27.0	13.7	20.4	24.1	22.8	33.5	40.4
B-4	632	617	632	612	605	591	51.5	61.5	30.0	37.0	29.7	28.0	13.0	8.8	24.9	22.2	34.0	47.2

[3] See Table 1, footnote 3.
[4] See Table 2, footnote 4.

pronounced color density increase with Pectinol while the second lot shows a decrease.

Pectinol had little effect on the hue of the press wine, but did have an effect on the color density. The Pectinol treated wine was much darker up to 29 months, but slightly lighter at the end of 55 months of aging.

TABLE 12

Color differences in McAdam units

Comparison	ΔC					
	1950 Dry Red[2]					
	0[4]	2	8	18	29	55
B-2:B-4	11.5	57.5	8.1	5.6	6.2	12.8

[2] See Table 1, footnote 3.
[4] See Table 2, footnote 4.

There is a decided variation in the reaction of the two lots of Ports to Pectinol. Reference to Table 4 shows that different varieties of grapes were used in the two lots. That these two lots are quite different is borne out by a comparison of the dominant wave lengths of the two, and by the marked decrease in dominant wave length with aging of the second lot of Port. Thus, the opposite reactions to the effect of Pectinol on color density may be mainly due to the grape varieties used.

TABLE 13

Must treatment

Sample no.	Unheated	Heated 85° C.	Fermented		Pectinol O lbs./1000 gals.	Press juice
			on skins	off skins		
1950 Dry Red[2]						
A-1	x		x		0	
A-2	x		x		1	
A-3	x		x		2	
A-4	x		x		4	
A-5	x		x		8	
1950 Dry Red[2]						
B-2		x		x	0	
C-1		x		x	1	
C-2		x		x	2	
C-3		x		x	4	
1950 Port[6]						
50-2		x		x	0	
50-3		x		x	1	
50-4		x		x	2	
50-5		x		x	4	
1950 Port[7]						
B-2		x		x	0	
B-3		x		x	1	
B-4		x		x	2	
1950 Dry Red[2]						
B-4		x		x	0	x
C-4		x		x	2	x

[2] See Table 1, footnote 3.
[6] See Table 4, footnote 6.
[7] See Table 4, footnote 7.

TABLE 14

Color characteristics of the musts and wines

Sample	Dominant Wavelength					% Purity (Degree Saturation)					% Y (Brightness)				
1950 Dry Red[2]															
	8[4]	18	29	55		8	18	29	55		8	18	29	55	
A-1	650	634	608	599		31.5	30.0	38.0	29.5		22.9	27.2	26.3	36.4	
A-2	640	630	612	600		33.5	31.0	35.5	30.1		21.9	26.8	25.6	36.1	
A-3	650	625	612	595		33.0	32.0	35.5	31.9		21.6	26.2	26.2	39.0	
A-4	640	622	612	593		32.0	33.0	35.7	32.5		23.3	25.5	26.5	43.8	
A-5	648	622	612	592		34.5	34.5	35.7	33.9		19.6	23.8	25.9	42.6	
1950 Dry Red[2]															
	0[4]	8	18	29	55	0	8	18	29	55	0	8	18	29	55
B-2	630	623	617	606	599	57.0	35.0	37.0	32.3	27.0	13.7	24.1	22.8	33.5	40.4
C-1	630	620	620	602	594	57.0	32.0	31.3	29.5	24.0	13.7	28.0	28.1	36.5	49.4
C-2	630	618	615	604	595	57.0	32.5	29.6	31.3	29.2	13.7	28.4	32.4	36.4	45.4
C-3	630	614	610	600	584	57.0	33.0	29.3	32.0	22.3	13.7	29.9	34.0	37.8	67.3
1950 Port[6]															
	0[4]	9	18	28	54	0	9	18	28	54	0	9	18	28	54
50-2	620	600	598	597	585	40.5	26.4	27.5	30.0	25.0	19.8	42.5	41.3	40.3	61.9
50-3	620	599	597	598	592	40.5	28.5	32.0	30.0	27.0	19.8	41.5	38.4	38.1	48.2
50-4	620	598	596	597	594	40.5	28.0	31.5	30.0	27.6	19.8	43.2	42.1	40.3	43.3
50-5	620	595	597	595	593	40.5	33.2	30.3	32.3	29.5	19.8	43.0	41.5	41.8	44.4
1950 Port[7]															
	0[4]	9	18	28	54	0	9	18	28	54	0	9	18	28	54
B-2	700	602	605	602	600	27.5	24.0	23.0	23.8	19.8	25.4	44.7	42.7	41.8	44.1
B-3	700	602	604	602	590	27.5	24.2	24.0	25.5	21.4	25.4	44.4	41.8	40.1	57.3
B-4	700	602	606	602	598	27.5	25.0	22.8	25.0	21.0	25.4	43.9	41.9	41.1	47.2
1950 Dry Red[2]															
	0[4]	8	18	29	55	0	8	18	29	55	0	8	18	29	55
B-4	632	632	612	605	591	51.5	30.0	37.0	29.7	28.0	13.0	24.9	22.2	34.0	47.2
C-4	632	624	625	614	590	51.5	47.2	46.3	47.5	31.0	13.0	15.1	15.9	18.4	49.4

[2] See Table 1, footnote 3.
[4] See Table 2, footnote 4.
[6] See Table 4, footnote 6.
[7] See Table 4, footnote 7.

TABLE 15

Color differences in McAdam units

Comparison	ΔC				
	1950 Dry Red[3]				
	8[4]	18	29	55	
A-1:A-2	3.2	1.2	3.9	1.2	
A-1:A-3	3.3	2.5	3.8	5.4	
A-1:A-4	1.5	4.5	2.5	12.1	
A-1:A-5	6.6	7.5	2.6	11.0	
	1950 Dry Red[3]				
	0[4]	8	18	29	55
B-2:C-1	0.0	9.8	11.9	10.8	12.1
B-2:C-2	0.0	11.0	19.7	5.5	8.0
B-2:C-3	0.0	14.0	24.0	7.0	33.4
	1950 Port[6]				
	0[4]	9	18	28	54
50-2:50-3	0.0	3.0	7.1	2.7	13.5
50-2:50-4	0.0	1.3	4.0	0.0	26.0
50-2:50-5	0.0	7.2	3.4	2.7	26.1
	1950 Port[7]				
	0[4]	9	18	28	54
B-2:B-3	0.0	1.0	2.3	2.6	15.0
B-2:B-4	0.0	2.0	1.2	1.2	2.5
	1950 Dry Red[3]				
	0[4]	8	18	29	55
B-4:C-4	0.0	37.8	40.0	48.1	2.7

[3] See Table 1, footnote 3.
[4] See Table 2, footnote 4.
[6] See Table 4, footnote 6.
[7] See Table 4, footnote 7.

Pectinol had no appreciable effect on the taste or aroma of the wines.

SUMMARY

Heat treatment of musts fermented on the skins slightly increases the red hue, increases the saturation, and markedly decreases the brightness (which is equivalent to an increase in the color density) of the wines. Increased treatment temperature of musts fermented off the skins results in a slight progressive decrease in redness and a significant decrease in color density. Heat treatment at 85-90° C. of musts fermented off the skins has little effect on either hue or color density. A retention time on the skins of 0.58-24 hours results in a slight increase in both redness and color density. A retention time of 72 hours with fermentation has the opposite effect. Pressing lessens the red hue and, on aging, the color density. Pectinol O decreased redness and color density in two lots, had the opposite effect in a third, an erratic effect in the fourth, and with press wine had no effect on the hue but a significant effect on the color density.

Aging resulted in a more or less marked decrease in the red hue as well as in the color density. In some lots it also caused a reversal in the initial effect of the treatment on both.

Fermentation on the skins of heat treated musts produced wines definitely inferior in quality. Pressing had the same effect. None of the other treatments materially affected the taste or aroma of the wines.

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Stability of Frozen Concentrated Orange Juice

I. The Effect of Heat Treatment on Enzyme Inactivation and Cloud Stability of Frozen Concentrate Made from Pineapple and Valencia Oranges[a]

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The effect of heat treatment on enzyme inactivation and cloud stability in frozen concentrate made from both Pineapple and Valencia oranges is reported. Various times and temperatures were employed. Temperatures of 150° F. and above reduced pectinesterase activity at comparatively short holding times. Cloud stability increased in the range of 170° to 180° F., showing that a factor other than pectinesterase inhibits separation and gelation at such temperatures.

During the past several years the use of some type of heat treatment for stabilizing purposes has become quite widespread in the manufacture of frozen orange concentrate. The purpose of the stabilizing process is to prevent a loss of quality, exhibited by gelation or separation, which may occur if the product is mishandled or abused during marketing. This loss of quality has been generally attributed to the activity of the enzyme pectinesterase *(5, 13)*. If the product is kept at 0° F., the enzyme activity is negligible; however, if it is allowed to thaw, the enzymatic action is more rapid and separation or gelation may result.

The stabilization procedure greatly reduces the occurrence of these changes by partially inactivating the enzymes. This is accomplished by passing either single strength or partially concentrated juice through a carefully controlled heat exchanger where it is rapidly brought to the desired temperature, possibly held for a short time, and then very quickly cooled. In either case no heat treatment is given the cutback juice from which the final desired flavor and aroma in the product are derived.

Although much information has been reported on the inactivation of the enzyme pectinesterase *(1, 11, 12)* and on cloud stability in citrus juice *(2, 3, 4, 6, 9, 10)*, there remained a need for additional studies on the practical application of the stabilizing treatment. As a result, a series of investigations was undertaken. This paper is concerned with the first of the series and deals with the effect of heat treatment on enzyme inactivation and cloud stability in frozen concentrate made from both Pineapple and Valencia oranges.

[a] A partial report on work conducted at the U. S. Citrus Products Station, Winter Haven, Florida, under a Memorandum of Understanding between the Continental Can Company, Inc., New York, N. Y. and the Southern Utilization Research Branch, Agricultural Research Service, U. S. Department of Agriculture.

PROCEDURE

All of the test variables used in this study were prepared and analyzed at the U. S. Citrus Products Station in Winter Haven, Florida.

To minimize the effect of fruit variation as a factor in this investigation, the oranges were handled as follows: For a given variety, all fruit came from the same grove and from the same block of trees. Units of approximately 100 boxes were picked and placed directly in 40° F. storage as required for processing. Boxes of fruit were removed at random for extraction and used within a week. Only two such lots were necessary for all variables of each variety.

Oranges were washed and their juice extracted with a Rotary Juice Press.[b] Rag and seed were removed by passing through a finisher equipped with a 0.033 in. screen. All the juice for a day's run was extracted, and pumped into a refrigerated tank, and held at 40° F. until used.

Equipment for heat treating juices under controlled conditions included a Cherry-Burrell[b] viscolizer pump which handled the juice at a flow rate of 125 gal./hour; a tubular type heat exchanger consisting of 33 feet of 5/16 in. O. D., 20-gauge stainless steel tubing coiled in a hot water jacket; holding chambers composed of ¼, 1, or 2 in. stainless steel tubing of calculated volumes; and an annular-type cooler. Temperatures of the juice leaving the heater were adjusted and maintained by automatic controls. Use of a constant flow through a small tube at high velocity and under pressure resulted in turbulence (Reynolds Number 26,000). Rapid circulation of hot water in the heater jacket permitted heating to the desired temperature in 0.8 second. Use of a constant flow rate and holding chambers of fixed volumes permitted excellent control of the holding time. Using ice water in the annular cooler permitted reduction of temperature to less than 90° F. in 3 seconds.

The heat-treated juice was concentrated in a falling film pilot plant evaporator. Approximately 15 gallons of juice were concentrated to 2 to 3 gallons of 55° Brix concentrate. The evaporator was operated at 75° F. with temperatures of the heating medium at 106°-120° F. The 55° Brix concentrate was cut back to 42° Brix with single-strength, unheated juice.

Pectinesterase activity was determined by the method reported by Bissett, Veldhuis and Rushing *(3)*.

The 42° Brix concentrate variables were tested for cloud stability by two methods. Samples of each variable were placed at 40° F. and their stability determined at regular intervals for at least 42 days and in some cases up to 70 days. Cloud index was determined on reconstituted concentrate by a method de-

[b] The mention of trade products does not imply endorsement over similar products not mentioned.

scribed by Loeffler (7), using an Evelyn Colorimeter equipped with a No. 720 filter.[6] High cloud index (light transmission) readings indicated clarification or poor cloud stability. The cloud stability was also determined by placing a portion of the reconstituted 12° Brix juice in a test tube which was then stored at 40° F. After 24 hours, the sample was visually graded as being either stable, partially separated, or completely separated. By using this method, it was possible to establish for the Evelyn Colorimeter the percent transmission range where a definite cloud loss became apparent. It was also possible to establish the range where the samples became completely separated. Partial separation became apparent with light transmission values of 32 to 36% for Pineapple and 36% to 40% for Valencia variety juices, while complete separation was indicated by light transmissions of 76% to 80% and 68% to 72%, respectively.

The Pineapple variables had an acid content of 1.03% and 12.8° Brix. The Valencia variables had an acid content of 0.99% and 11.95° Brix.

[6] It is well known that different instruments have different characteristics and, therefore, do not give the same cloud readings for any given solution or suspension. The use of bentonite suspensions as suggested by Senn and O'Conner "A Proposed Standard for Designation of Cloud in Citrus Juices" (in preparation) would serve as a common denominator among instruments. Should the reader wish to compare the data given with other "cloud" studies, the following bentonite solutions and their respective colorimeter values for the instrument used are given:

Bentonite g./L.	0.0	0.5	1.5	2.5	3.5	4.5
Colorimeter Reading	100.0	71.8	46.8	31.5	23.0	17.8

RESULTS AND DISCUSSION

Enzyme inactivation. The results of the heat stabilizing treatment on the pectinesterase acitvity in frozen orange concentrate made from Pineapple and Valencia oranges are shown in Tables 1 and 2. Determinations were made on single-strength juice or concentrate reconstituted to 12° Brix and results reported as percent inactivation based on unheated, single-strength juice as the standard. These data indicate the effect of the various treatments on the enzyme system in single strength, 55° Brix concentrate, 42° Brix final products and the stability of the cloud system in 42° Brix products when stored at 40° F. In preparation of 42° Brix frozen

TABLE 1

Effect of heat treatment on pectinesterase activity of Pineapple orange juices and concentrates

Seconds hold time	% Inactivation			Days stable[4] at 40° F.
	B[1]	C[2]	D[3]	
140° F. Series				
5	26	14	25	4
15	50	51	48	6
30	38	58	52	8
60	52	68	67	9
120	61	70	72	9
150° F. Series				
1	16	38	21	2
5	63	71	73	10
15	74	79	80	12
30	84	80	82	10
60	80	83	83	10
120	80	87	80	10
160° F. Series				
1	74	79	75	10
5	89	88	83	15
15	90	89	82	15
30	91	89	85	9
60	89	89	85	9
90	88	87	83	9
170° F. Series				
1	88	88	79	15
5	90	90	78	15
10	89	88	79	10
15	91	89	85	10
30	91	89	85	8
60	92	100	86	7
180° F. Series				
1	92	86	84	20
5	94	100	84	34
10	90	100	86	16
15	93	91	84	20
30	94	92	82	12
190° F. Series				
1	83	93	85	39
3	85	95	86	68
5	94	98	88	72
10	95	95	89	72
15	98	98	91	72
200° F. Series				
1	90	95	89	72
3	90	100	94	72
5	99	100	91	72
210° F. Series				
1	98	99	89	72
3	100	100	91	72

TABLE 2

Effect of heat treatment on pectinesterase activity of Valencia orange juices and concentrates

Seconds hold time	% Inactivation			Days stable[4] at 40° F.
	B[1]	C[2]	D[3]	
140° F. Series				
5	12	28	7	4
15	21	47	39	6
30	19	42	41	8
60	52	49	54	8
120	43	56	51	8
150° F. Series				
1	31	35	34	8
5	64	67	56	16
15	77	82	73	22
30	60	79	77	16
60	82	75	77	14
120	82	81	78	11
160° F. Series				
1	61	75	66	19
5	75	86	78	22
15	87	89	82	23
30	92	87	85	16
60	91	88	86	14
90	89	89	84	14
170° F. Series				
1	86	90	82	32
5	93	92	85	21
10	88	91	85	16
15	88	89	84	19
30	93	91	87	15
60	92	93	86	10
180° F. Series				
1	91	92	84	45
5	90	90	79	42
10	90	91	85	24
15	93	92	85	47
30	93	92	89	24
190° F. Series				
1	94	91	87	70
3	94	90	87	70
5	97	95	89	70
10	92	96	89	70
15	96	97	91	70
200° F. Series				
1	97	95	92	70
3	99	95	88	70
5	100	98	94	70
210° F. Series				
1	98	97	93	70
3	99	97	92	70

[1] B = Heat treated single strength juice. [2] C = 55° Brix concentrate made from B. [3] D = 42° Brix concentrate made from C cut back with unheated single strength juice. [4] 42° Brix "D" product only.

concentrates, the proportion of cutback juice to evaporator feed juice is approximately 1 to 10.5; thus the unheated cutback represents 8.3% of the total.

The results in Tables 1 and 2 show that heat treatment at 150° F. for 15 seconds or longer will reduce the pectinesterase activity in the final product to 25% or less of the original activity. Temperatures of 160° F. and above for 5 seconds also reduced the pectinesterase activity to this level. Under the conditions of this investigation little benefit was gained by increasing the length of the hold time to a period longer than 15 seconds, with the exception of the 140° F. series where there was a definite increase in inactivation as the hold time increased up to 60 seconds. Increasing the *hold* time beyond this point and up to 120 seconds did not greatly benefit enzyme inactivation for either variety.

Figures 1 and 2 show the effect of heat treatment on the pectinesterase activity and cloud stability of frozen orange concentrate made from Pineapple and Valencia oranges. The stability curve represents the average number of days the 42° Brix concentrates remained stable at 40° F. for each treatment temperature.

With increasing treatment levels, pectinesterase activity decreased and stability time increased. Treatment temperatures of 180° F. gave about 3 weeks stability to Pineapple and Valencia concentrates. The length of the holding time had little effect on the pectinesterase activity in the temperature range of 160° F. and above.

Although there was comparatively little difference in percent pectinesterase activity remaining in the final

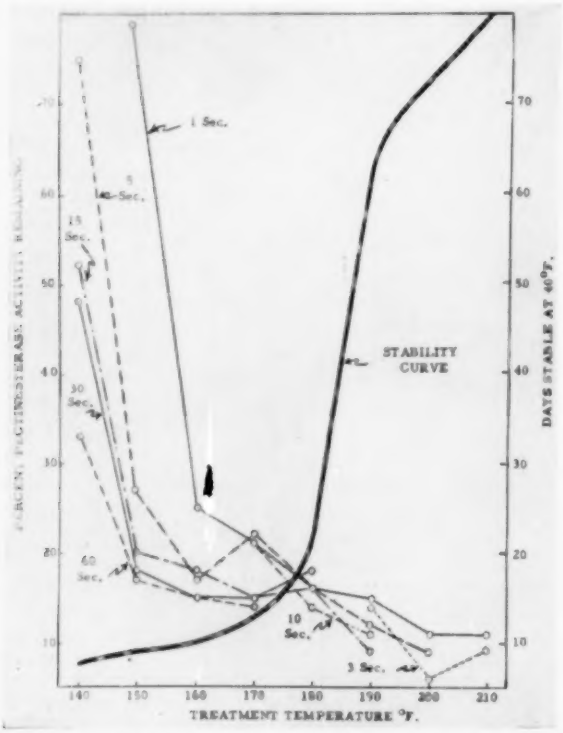

Figure 1. The effect of heat treatment on the pectinesterase activity and cloud stability of frozen orange concentrate made from Pineapple orange juice.

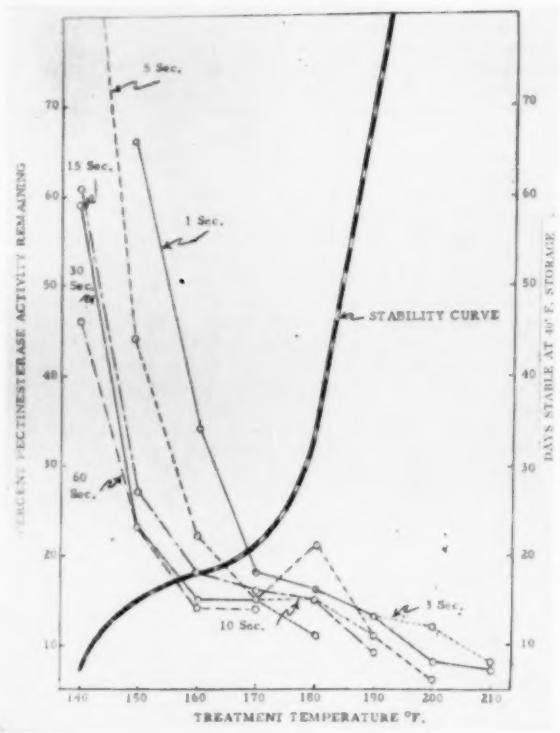

Figure 2. The effect of heat treatment on the pectinesterase activity and cloud stability of frozen orange concentrate made from Valencia orange juice.

product between heating at 150° F. and 210° F., there was a very marked difference in cloud stability. This is quite clearly shown in Figures 1 and 2. There was a pronounced increase in the cloud stability at 180° F. compared with 170° F. for both varieties without a proportional change in the residual pectinesterase activity. Although there appears to be a definite association between enzyme activity and stability, the effects are not proportional. It appears that there is some effect of heat treatment, other than the inactivation of pectinesterase, which prevents separation and gelation. It is possible that this change in stability is the result of the heat treatment on the pectic substances in the juice or it may be that a second enzyme system is involved in the separation and gelation of frozen concentrated orange juice.

Cloud stability. The effect of heat treatment on cloud stability at the various temperatures under study are shown in Figures 3-9. Only the 5- and 15-second holding times were selected for presentation, since it was found that this range appeared to be the most effective for cloud retention. A one-second holding time was effective for cloud retention at 160° F. and above, but not effectve at 150° F. The longer holding times included in this investigation are discussed later.

The stability curves of 42° Brix concentrate made from Pineapple orange juice heat stabilized for 5 seconds at various temperatures (1953) are shown in Figure 3. The results show that under 40° F. storage the control remained stable less than 24 hours; heating to 140° F.

and subsequent 10° intervals to 200° F. effected stability in the product from 4 days to 70 days.

The stability curves of 42° Brix concentrate made from Pineapple orange juice heat treated for 15 seconds at various temperatures (1953) are shown in Figure 4. Results show the same trend as Figure 3; increasing the heat treatment from 140°-200° F. increased stability from 6 days to at least 70 days when the juice was stored at 40° F.

The stability curves of 42° Brix concentrate made from Valencia orange juice heat-treated for 5 seconds at various temperatures (1953) are shown in Figure 5.

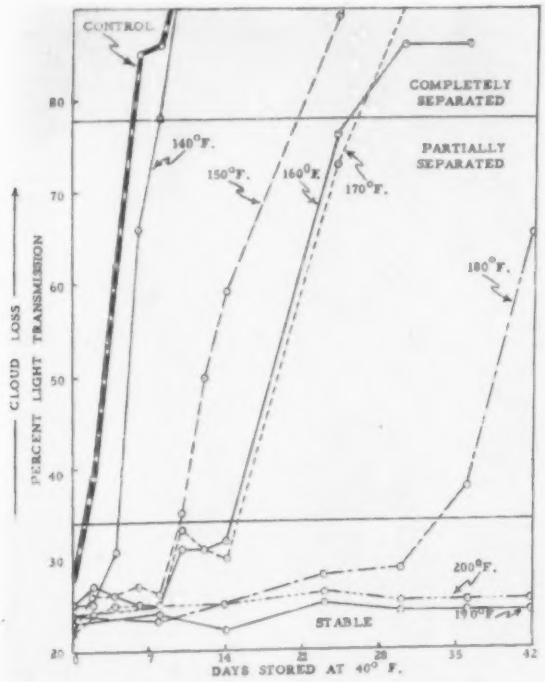

Figure 3. The stability of 42° Brix concentrate made from Pineapple orange juice heat stabilized for 5 sec. at various temperatures (Brix 12.7°—Acid 1.04%).

The control, which received no heat treatment, remained stable for nearly 4 days. Heat treating at 150° F. for 5 seconds did not appreciably increase the stability of the product. Little difference was noted between the variables heated to 150° F., 160° F., and 170° F. which remained stable for 16 to 23 days. It should be noted that these samples did not become completely separated, by the standards used for this investigation, even after 42 days' storage at 40° F. As noted before in the case of the concentrate made from Pineapple orange juice, heat treatment at 180° F. was much more effective than at 170° F., as samples thus treated remained stable for 42 days. Samples of either juice heated to 190° F. or 200° F. for 5 seconds remained completely stable, losing none of their original cloud over the entire storage period of 70 days.

Stability curves for concentrates prepared from Valencia orange juice heat-treated for 15 seconds at

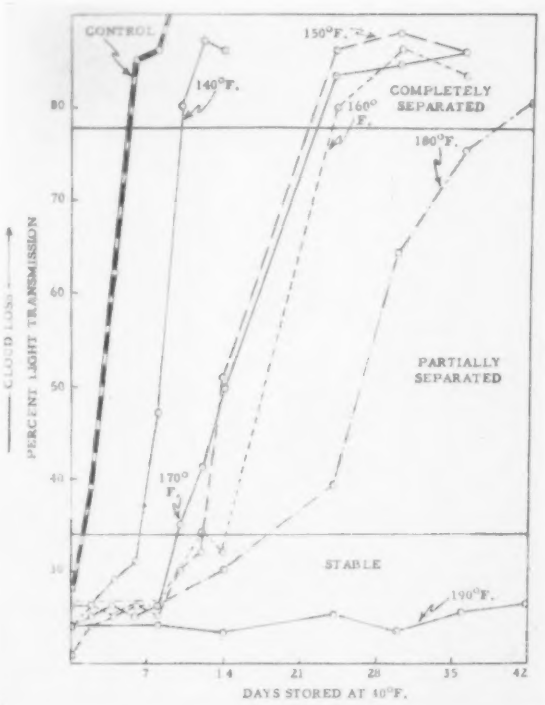

Figure 4. The stability of 42° Brix concentrate made in 1953 from Pineapple orange juice heat stabilized for 15 seconds at various temperatures (Brix 12.8°—Acid 1.03%).

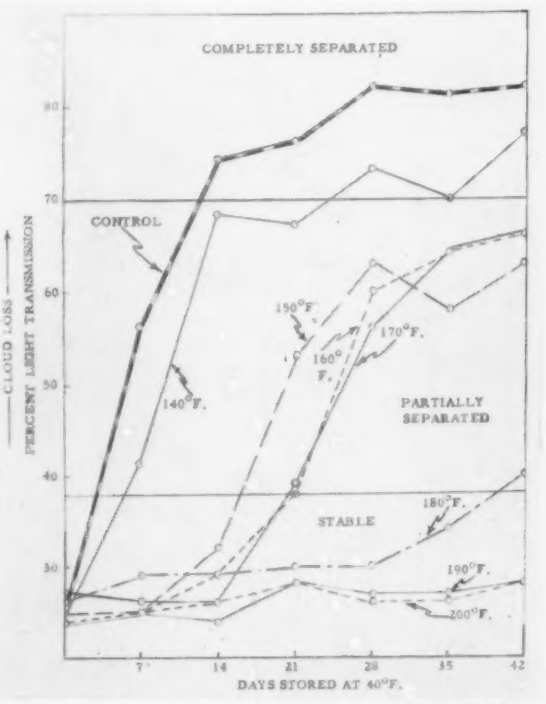

Figure 5. The stability of 42° Brix concentrate made in 1953 from Valencia orange juice heat stabilized for 5 seconds at various temperatures (Brix 11.9°—Acid 1.00%).

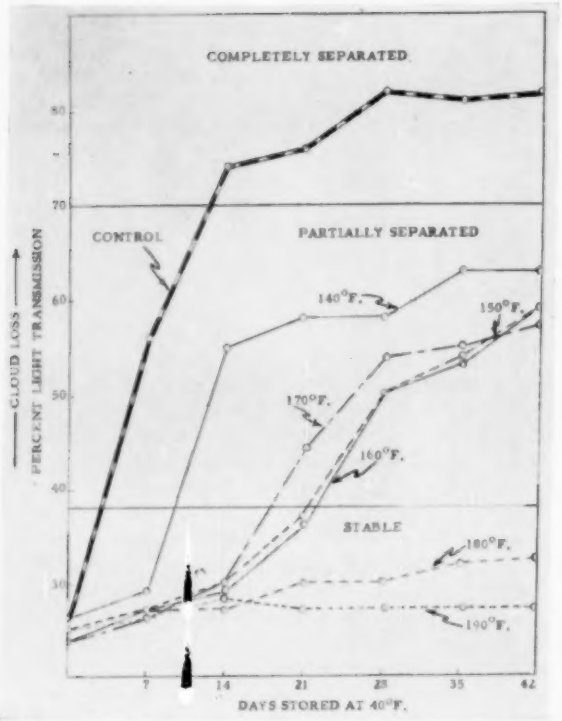

Figure 6. The stability of 42° Brix concentrate made in 1953 from Valencia orange juice heat stabilized for 15 seconds at various temperatures (Brix 12.4°—Acid 1.04%).

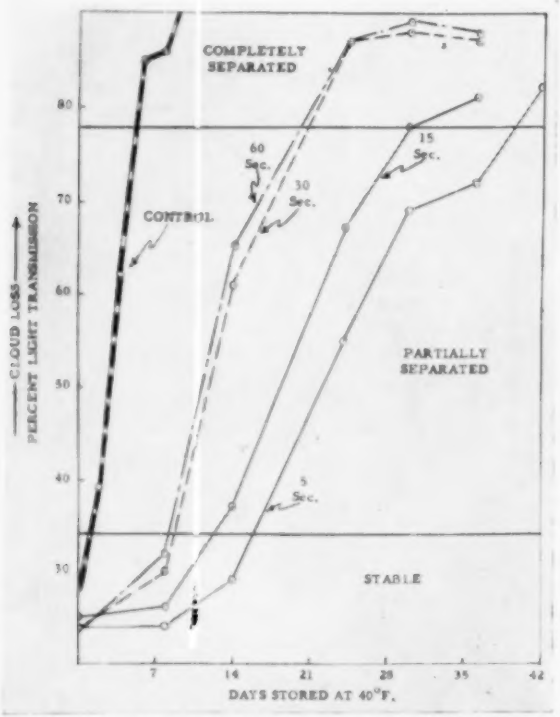

Figure 7. The effect of hold time on the stability of 42° Brix concentrate made in 1953 from Pineapple orange juice. (Curves represent average of heat treatments at 160°F., 170°F., and 180°F. for the specified holding time).

various temperatures are shown in Figure 6. Although these curves are not identical to those where 5-second treatments were applied, they are quite comparable. It will be noted that none of the heat-treated variables became completely separated during the entire 42-day storage period.

From the data presented, it was concluded that the Valencia orange juice used for this investigation had less tendency to separate and was more easily stabilized than the juice from Pineapple oranges.

The longer holding times at the lower temperatures were included in the investigation, since it was reasoned

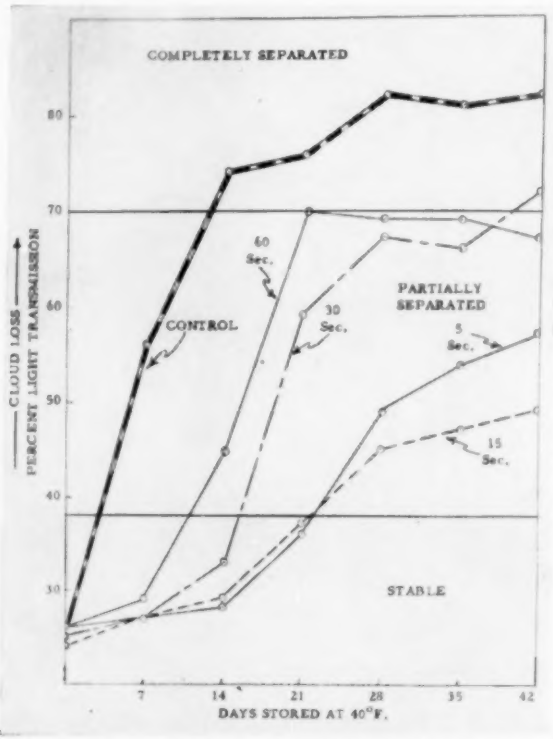

Figure 8. The effect of hold time on the stability of 42° Brix concentrate made in 1953 from Valencia orange juice. (Curves represent averages of heat treatments at 160° F., 170° F., and 180° F. for the specified holding times).

that as the length of holding time increased, there should be a corresponding increase in enzyme inactivation as well as cloud stability. However, this was not the case at all temperatures. It was obesrved that when a 140° F. or 150° F. heat treatment was used, an increase in holding time did increase the stability. However, at 160° F. and including 170° F. and 180° F., the results show that the longer the holding time above a range of 5 to 15 seconds, the less effective the heat treatment as far as stability is concerned. This contradicts what was expected, since it was assumed that the longer the holding time, the longer would be the stability period for a given temperature. Keller *et al. (6)* have reported the same phenomenon.

The effects of holding time on the stability of 42° Brix concentrate are shown in Figures 7-9. Each curve repre-

sents an average cloud stability for samples heat-treated at 160° F., 170° F., and 180° F., for a specified holding time. The curves in Figure 9 were obtained from a study made on Pineapple oranges in 1954 to verify results previously obtained and presented in Figures 7 and 8. The data presented in the figures show that at 160° F., 170° F., or 180° F. a 5- or 15-second holding time will result in a more stable product than a 30- or 60-second holding time. Whether the same response would occur at 190° F., 200° F., or 210° F. is not known, since the longer holding times at these temperatures were not included in this investigation.

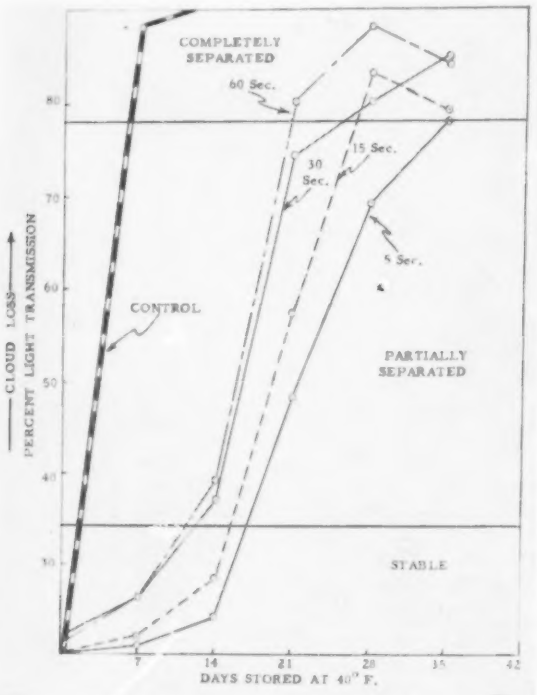

Figure 9. The effect of hold time on the stability of 42° Brix concentrate made in 1954 from Pineapple orange juice. [Curves represent averages of heat treatment at 160° and 170° F. for the specified holding time. (Brix 9.6° — Acid 0.77%)].

It is suggested that the response as shown in Figures 7-9 may be due to a rapid hydrolysis of the pectin at the treatment temperature during the 30- or 60-second holding period. If this is true, then the chemical or physical state of the pectin in the sample would be such that less enzyme activity would be required to cause a more complete pectin breakdown and subsequent loss of cloud. On the other hand the chemical or physical state of the pectin in the sample which received the same temperature treatment for only 5 or 15 seconds would be such that a longer storage period at 40° F. or, in other words, more enzyme activity would be necessary to bring about cloud loss.

The results presented in this report as well as those reported by Keller *et al. (6)* indicate that although there is a definite association between enzyme activity and cloud stability there are other factors which also play important roles in the maintenance of cloud in frozen orange concentrate. As has been pointed out by McColloch and Rice *(8)*, the acquired sensitivity to cloud loss may be such that only a small amount of enzyme activity may be enough to upset the delicate balance necessary for cloud maintenance. Whereas under other conditions a great deal of enzyme activity may be necessary to cause cloud loss. Therefore, the use of pectinesterase activity determinations as an indication of cloud stability may be very misleading, and some method perhaps similar to that reported by McColloch and Rice *(8)* might give more valid results.

SUMMARY

An investigation was undertaken to determine the effect of heat treatment at various times and temperatures on enzyme inactivation and cloud stability of frozen orange concentrate made from both Pineapple and Valencia oranges. The juice to be evaporated was heat-treated in a small tube turbulent flow heat exchanger for specified times at selected temperatures. In every case, unheated single-strength juice was used for cutback.

The results show that a change in the temperature of heat treatment had a more pronounced effect on enzyme inactivation than did a change in holding time at any given temperature. Temperatures of 150° F. and above, with the exception of several of the shorter hold times, reduced the pectinesterase activity in the final product to 25% or less of the original activity.

There was a pronounced increase in cloud stability in the temperature range of 170° F. to 180° F. without a corresponding change in enzyme activity, indicating there is some factor other than the enzyme pectinesterase which is affected by heat treatment and which inhibits separation and gelation.

Concentrate made from Valencia orange juice had less tendency to separate than the concentrate made from the Pineapple variety. Temperatures of 150° F. and above were effective in delaying the loss of cloud with both Pineapple and Valencia concentrates. In the temperature range of 160° F. to 180° F., heat treatment for longer than 15 seconds was less effective for stabilization than heat treatments for 5 to 15 seconds.

Acknowledgment

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The Effect of Cooling and Freezing Procedures on Consumer Acceptability Factors of Turkey Meat[a, b]

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The effects of five cooling treatments and three freezing temperatures on factors of consumer acceptability were studied. A total of 180 turkeys was used. The study was replicated with turkey fryers, young hens, young toms, and mature hens.

Marketing turkeys as pan-ready instead of dressed birds has been accompanied by many changes. These include increased scalding temperatures and a change in marketing methods; namely, the greatly increased sale of frozen birds. The impact of these changes on consumer acceptability factors should be known. The effect on yield of salable meat is also of major importance.

At this time most turkeys in the Western states are processed using water temperatures in excess of 138° F. This procedure requires that the surface of the bird be kept moist at all times—until it is frozen, during and after thawing, and until it is placed in the oven. Processors have achieved this by ice chilling, packaging, and freezing, or by direct packaging and freezing.

Lowe *(3)* comprehensively reviewed previous work relating to palatability of poultry. A later report by Koonz, Darrow, and Essary *(2)* suggests that processors who follow the method of packaging and freezing directly without cooling may have a problem with tenderness of the cooked meat. The effect on carcass appearance of freezing *(1)* and of scald temperatures *(4)* has been reported.

The purpose of this study was to determine the effect of several cooling treatments on appearance, weight changes, and tenderness of turkeys frozen at three temperatures.

EXPERIMENTAL

Turkey fryers, young hens, young toms, and mature hens were processed by subscald (140° F., 60° C.) procedure. All turkeys were immediately eviscerated and scored for general appearance. In scoring, 5 was given for best possible appearance, down through 1 for unsalable birds. The turkeys were then divided at random into 4 cooling treatments and one "no cooling" treatment, 3 birds to each treatment.

The methods were: (a) ice water; (b) drained snow ice; (c) air at 34° F. (1.1° C.), birds enclosed in a wet canvas shroud; (d) air at 34° F. (1.1° C.) birds enclosed in a polyethylene bag; and (e) no cooling. Instead (e), warm eviscerated birds were taken directly from the eviscerating line to the freezer. Prior to freezing, each bird was packaged in a polyethylene bag.

The cooling period was of 16 to 20 hours' duration. The uncooled birds for treatment (e) were dressed, eviscerated and scored to coincide with the end of the cooling period for treatments a, b, c, and d, so that all turkeys were moved to the freezers simultaneously.

The freezing temperatures used were 0° F., —20° F., and —40° F. (—17.8° C., —29° C., and —40° C.). With each of these temperatures, a fan was used to keep air movement around the turkeys at approximately 500 feet per minute to accelerate the rate of freezing *(5)*. As soon as the slowest freezing turkey reached an internal temperature of +5° F. (—15° C.) in the deepest breast muscle along the keel, all turkeys were removed from the freezers, unpackaged and scored on the basis of general appearance.

[a] Scientific Paper No. 1447, Washington Agricultural Experiment Stations, Pullman, Project 1076.

[b] Presented at the Fifteenth Annual Meeting of IFT, Columbus, Ohio, June 15, 1955.

Each turkey was weighed after eviscerating, after cooling, and after freezing treatments. After the final weighing the frozen birds were sawed in half and one half was placed in 0° F. (−17.8° C.) storage for a period of about 10 weeks prior to studying for weight changes on thawing and cooking. Tenderness observations on the cooked meat were also made at this time. These weight changes were obtained by weighing the frozen half and then replacing it in a polyethylene bag and allowing it to thaw at room temperature, 68° F. (20° C.) for 20 hours before weighing again. After the thawed weight was obtained, the leg and breast were removed from the half carcass. The leg and breast were individually weighed prior to wrapping in aluminum foil for roasting in an oven at 300° F. (149° C.). Roasting times were adjusted for the class of turkeys being cooked. Immediately after cooking and draining the parts were again weighed. Tenderness of a section of the breast muscle (*pectoralis major*) and of two muscles of the thigh (*semimembranosus* and *semitendinosis*) was determined using a shear force tenderometer modified from the original Warner-Bratzler to give readings in grams. The size of the muscle used was standardized by using two scalpels placed 1 cm. apart in a rigid frame and cutting a section 1 cm. square for the length of the muscle parallel to the fibers.

The study was replicated three times with fryers, twice with young hens, four times with young toms, and three times with mature hens.

RESULTS AND DISCUSSION

In all instances the turkeys cooled in ice water had a higher score for appearance than did turkeys cooled by other procedures. The turkeys cooled in drained snow-ice and in air (carcass covered with a canvas shroud) had some discolored areas due to dehydration. Discoloration, but to a lesser degree, was also evident in the turkeys air cooled in polyethylene bags. Where the film was in contact with the skin, a white color similar to ice-water cooled birds resulted. This gave the turkeys a blotched appearance. The appearance scores determined after cooling and freezing, respectively, were subjected to analysis of covariance. In each case the score of the freshly eviscerated birds was used as the independent variable. Scores after cooling were significantly lower ($P < 0.01$) but subsequent freezing masked out many of the appearance differences. Freezing rate affected the appearance of frozen birds with relatively little fat covering, especially fryers and young toms.

The cooler the freezing temperature, the higher the appearance score of fryers and young toms not previously cooled. There were no statistically significant differences in scores due to freezing temperatures of either young or mature hens. The mean appearance scores of frozen young tom turkeys are listed in Table 1. Slightly greater differences due to freezing temperatures were found with turkey fryers.

TABLE 1

The effect of cooling procedure and freezing temperature on mean appearance score of young tom turkeys processed at 140° F. (60° C.), mean initial score 4.4, maximum score 5.0.

Cooling treatment	Freezing temperature (° F.)		
	0	−20	−40
Canvas shroud in air	2.4	3.3	3.0
Polyethylene in air	2.5	3.6	3.3
Drained snow-ice	3.0	4.1	3.7
Ice water	4.0	3.8	4.5
No cooling	2.5	3.1	3.3

Weight changes during cooling varied from a loss in weight of over 1% for the air-cooled canvas covered turkeys to a gain of over 5% for the ice-water cooled turkey fryers. The change was highly significant statistically, ($P < 0.01$), for all classes of turkeys with the same level of significance being carried through to frozen weights. Percentage weight changes for young tom turkeys from warm eviscerated weight to frozen weight are listed in Table 2.

TABLE 2

The effect of cooling procedure and freezing temperature on percentage weight changes during cooling and freezing of young tom turkeys

Cooling treatment	Freezing temperature (° F.)		
	0	−20	−40
	%	%	%
Canvas shroud in air	−1.4	−1.2	−0.8
Polyethylene in air	−0.7	−0.6	−0.8
Drained snow-ice	−0.2	+0.7	+0.7
Ice water	+3.0	+3.5	+3.6
No cooling	−0.6	−0.8	−0.4

The moisture lost during thawing is readily observable and therefore is an important factor in consumer appeal. The loss in weight during thawing was significantly affected by cooling treatment. Losses for other than ice-water cooled birds averaged about 2% for turkey fryers; 1.5% for young toms; 0.5% for young hens and mature hens. The ice-water cooled birds lost from 2 to 4% during thawing with highest losses found in fryers and young toms. Apparently the amount of fat on the carcass affected the moisture loss during thawing. There was a tendency for the turkeys frozen at 0° F. (−17.8° C.) to lose slightly more in weight during thawing than those turkeys frozen at lower temperatures. The effects of cooling treatment and freezing temperatures on weight loss during thawing of young tom turkeys are evident from data in Table 3. Weight changes during cooking of young toms are also listed in this table.

TABLE 3

The effect of cooling procedure and freezing temperature on percentage weight lost during thawing and cooking of young tom turkeys

Cooling treatment	Freezing temperature (° F.)					
	0		−20		−40	
	Thawing	Cooking	Thawing	Cooking	Thawing	Cooking
	%	%	%	%	%	%
Canvas shroud in air	0.9	34.8	1.1	34.4	0.8	34.9
Polyethylene in air	0.8	35.1	0.9	33.8	0.9	34.2
Drained snow-ice	1.3	34.9	1.6	33.9	1.0	33.9
Ice water	2.4	35.9	3.1	35.9	2.7	35.4
No cooling	1.5	35.3	1.3	35.1	1.3	34.9

The weight loss during cooking was not as consistently influenced by cooling treatment as were other weight changes measured. In all classes of turkeys, the weight loss during cooking by the ice-water cooled birds was greater than the loss from turkeys in other cooling treatments. The differences, however, reached statistical significance only for young toms (Table 3) and mature hens.

Tenderness of the cooked meat was influenced by the cooling treatment. Values obtained with young

toms are given in Table 4. The differences were not always statistically significant, but differences were always in the same direction. In general, the uncooled birds were less tender than the cooled turkeys. It is quite possible that the differences between treatments were reduced by the thawing period. Unresolved rigor in carcasses not subjected to cooling may have been resolved. Although differences were not all statistically significant, they were in agreement with results of Koonz *et al. (2)*. If the turkeys had been roasted without a thawing period the magnitude of differences would possibly have reached similar proportions *(2)*.

TABLE 4

The effect of cooling procedures and freezing temperature on force required to shear a 1 sq. cm. cross section of muscle from cooked young tom turkeys

Cooling treatment	Freezing temperature (° F.)					
	0		−20		−40	
	Breast	Thigh	Breast	Thigh	Breast	Thigh
	g.	*g.*	*g.*	*g.*	*g.*	*g.*
Canvas shroud in air	2168	2996	2325	2613	2205	2863
Polyethylene in air	2434	2470	2445	2855	2254	2806
Drained snow-ice	2698	3440	2461	2936	2484	3623
Ice water	2529	2944	2358	2576	2168	3336
No cooling	2790	4520	2965	4094	2774	3070

SUMMARY

The effects of 5 cooling treatments and 3 freezing temperatures on consumer acceptability factors for turkeys were checked.

Turkeys cooled in ice water had a better appearance, gave a net gain in weight during cooling and freezing, but lost the most weight during thawing and cooking. Such turkeys were equally tender compared with turkeys of other cooling treatments involving a 16-hour cooling period.

Turkeys placed in the freezers without a prior cooling period tended to be somewhat less tender than precooled turkeys.

The appearance of frozen turkeys was influenced by freezing rate. Generally, the lower the freezing temperature the better the appearance of the frozen bird. This effect was much more evident on turkey fryers and young toms than on young or mature hens.

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Considerations in Sulfiting Sweet Corn with an Aqueous Salt Solution Prior to Dehydration[a, b]

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A study was made on the effect of certain chemical, biological, and processing factors upon the uptake of sulfite by sweet corn from an aqueous solution of the sodium salts. The effect of the several variables investigated was noted by determining the amount of sulfite absorbed by the gross sample of cut sweet corn, by subgroups divided as to particle size, and by specific portions of the corn kernel. The mode of entry of the sulfite into the corn kernel was of major interest.

Previous work in this laboratory indicated that of the processing, dehydration and storage variables studied, the concentration of sulfur dioxide in the sweet corn was the most important single factor determining dehydrated product quality and storage stability *(1)*. However, observers here and elsewhere *(4)* noted that dried sweet corn samples which had been subjected to immersion in an aqueous solution of sulfite salts prior to dehydration contained particles having widely different concentrations of sulfite and different degrees of brown discoloration. Uniform sulfiting of sweet corn kernels and kernel portions is desirable in order to protect all sample particles against rapid chemical browning during storage without over-dosage to the point of imparting an objectionable sulfite taste to the final product.

Therefore, the purpose of this work was to obtain basic information on the mechanism of sulfite absorption from an aqueous salt solution by sweet corn which had been cut from the cob and blanched. Several raw material and sulfiting process variables were investigated for their effect on the quantity of sulfite absorbed and on the uniformity of its application.

[a] Presented at the Fifteenth Annual Meeting of IFT, Columbus, Ohio, June 14, 1955.

[b] Submitted by the senior author in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Food Technology at the University of Illinois, Urbana.

MATERIALS AND METHODS

Golden Cross hybrid was the variety of sweet corn used for these studies. After harvesting, the ears were husked and kernels cut from the cob mechanically. The washed and cleaned corn was conveyed on a wire mesh belt through a steam blanching chamber where it received a two-minute treatment at atmospheric pressure. In some experiments blanched corn was frozen and stored at —40° F., and then thawed before use. Blanched, cut corn was used for all the sulfite treatments.

Sulfur dioxide was supplied from a mixture of sodium bisulfite and sodium sulfite. The two salts were used in such a ratio that each contributed equally to the total theoretical quantity of SO_2. Zeolite softened water was used to prepare the solutions. The pH reaction of each solution was adjusted with HCl or NaOH solutions. Two procedures were used to treat the blanched corn with sulfite solutions. One method was to immerse 8 parts of corn in 3 parts of solution for the desired time. The other procedure was to place a small quantity of corn in a kitchen strainer and then immerse the strainer in a large volume of sulfite solution. Both dipping treatments were followed by a five-minute free drain. The solution-corn mixtures were agitated during immersion to insure uniform exposure by all particles to the solution. For one experiment kernels were impaled on rows of nails driven through a masonite board which rested on the top of a shallow pan containing sulfite solution.

Some samples were rinsed subsequent to sulfiting by dipping the corn, contained in a strainer, into a large volume of fresh water. In several distribution experiments, kernels were pierced through the pericarp into the crown region of the endosperm prior to sulfiting. Regular sewing needles with soldered guards to regulate the depth of puncture were used.

Two through-air-flow dehydrators were employed for drying samples. The drying schedules previously developed in this laboratory *(1)* for dehydrating sweet corn were generally followed. The moisture conditions of the corn at the various levels of dehydration are reported in terms of the "T" value, which is defined as the ratio of the weight of water to the weight of bone dry corn solids.

Samples were separated into six categories for distribution investigations. These were: whole kernels, tip cap intact; whole kernels, tip cap missing; ¾ kernels; ½ kernels; free fragments (kernel hulls which had been torn loose in processing); and free germs. In the studies concerning sulfite uptake from solution by blanched corn, the samples were segregated into the free fragments which had little or no adhering endosperm and the largest whole entities which might include particles from the first four categories listed above, depending upon the availability of each in the sample. It was a matter of personal judgment in regard to choosing ¾ and ½ kernels from the bulk lots of dried corn. The separations were made manually with the aid of a small forceps.

The dissections of the kernels into parts were carried out manually using a forceps and a razor blade. These long procedures necessitated packing and freezing small quantities of samples at frequent intervals to insure against appreciable sulfite losses at room temperature.

All samples awaiting analysis were frozen and stored at —40° F. The samples taken for determination of sulfite pick-up by blanched corn were stored in cellophane lined freezing cartons. All other samples were stored in hermetically sealed containers under vacuum, since the former method was found to entail some loss in sulfite even at —40° F. This loss, however, was not serious enough to affect the trends reported.

The direct iodometric titration method of Potter and Hendel *(3)* with modifications was used for sulfite analysis *(1)*. The precision of this method for dehydrated corn was found to be below 50 p.p.m. of SO_2. In the case of freshly sulfited or of partially dehydrated samples the precision was estimated to be about half that for fully dried corn. Because of the varying moisture contents of the samples used for the investigations, it was decided to express sulfite as parts of sulfur dioxide per million parts of dry corn solids.

Both the Steinlite and vacuum oven moisture determinations were employed for freshly sulfited corn *(1, 2)*. In case of the latter method, corn was macerated in an Osterizer for 2.5 min., placed in an air oven at 80° C. for 5 hours, and finally transferred to a vacuum oven at 100° C. and under 30 mm. Hg. for 5 hours. The moisture content was determined by grinding the dried corn in a Wiley mill to 20 mesh and placing it in a vacuum oven for 16 hours at 70° C.

RESULTS AND DISCUSSION

Initial survey. The degree of unevenness of sulfiting in three dehydrated sweet corn samples is shown by the data in Table 1. The sulfite content increased as kernel intactness decreased. It was noted that as kernel intactness decreased the visual evidence of browning was less apparent.

TABLE 1

Content of sulphur dioxide in particles of varying degree of kernel wholeness contained in stored samples of dehydrated sweet corn

Sample drying conditions	S-1-5 med. temp. p.p.m. SO_2	S-2-2 low temp. p.p.m. SO_2	S-1-8 med. temp. p.p.m. SO_2
Whole Kernels, Tip Cap Intact	780	690	410
Whole Kernels, Tip Cap Missing	920	1000	730
¾ Kernels	1120	1400	1060
½ Kernels	2080	2070	1990
Free Fragments	5640	6220	5440
Free Germs	1680	1620	1980
Whole Sample	1810	1960	2180

Storage conditions: Three months in vacuum at 70° F.
Initial sulfite treatment: One minute dip in 1% SO_2 solution of pH 6.7.

Factors affecting sulfite uptake by blanched corn. The results indicated that sweet corn picked up the largest proportion of its sulfite within a short period after immersion. Figure 1 shows that for a .5% SO_2 solution, the uptake occurred largely during the first minute of a 30-minute dipping interval. Temperature of the dipping solution showed little effect on sulfite uptake when going from a temperature of 67° F. to 120° F. The effect of solution concentration for short dipping periods is shown in Figure 2. As would be expected, sulfite uptake by the corn increased with an increase in concentration from .5 to 1.0%. It is interesting to observe that as the sulfite dipping solution concentration increased, the margin between the sulfite contents of the fragments and of the whole kernels also increased. The same effect was observed with concentrations of dipping solutions above 1% with margins between whole kernels and fragments substantially increased. Therefore, high concentration dipping solutions are not recommended for sulfiting sweet corn. When .5 and 1.0% SO_2 solutions (Figure 2) were used most of the sulfite was taken up during the first 10 seconds and for 2.5 and 5% solutions during the first 2 seconds.

Figure 3 shows that sulfite uptake by sweet corn was generally greater in acid solution than in alkaline solution. There is an indication of a maximum sulfite uptake at a pH of 5. The dissociation constants of aldehyde-sulfite compounds are probably irregular functions of pH. The phenomena of adsorption and of membrane permeability may also be functions of pH. Therefore, the finding that sulfite uptake varied irregularly with pH should not be surprising.

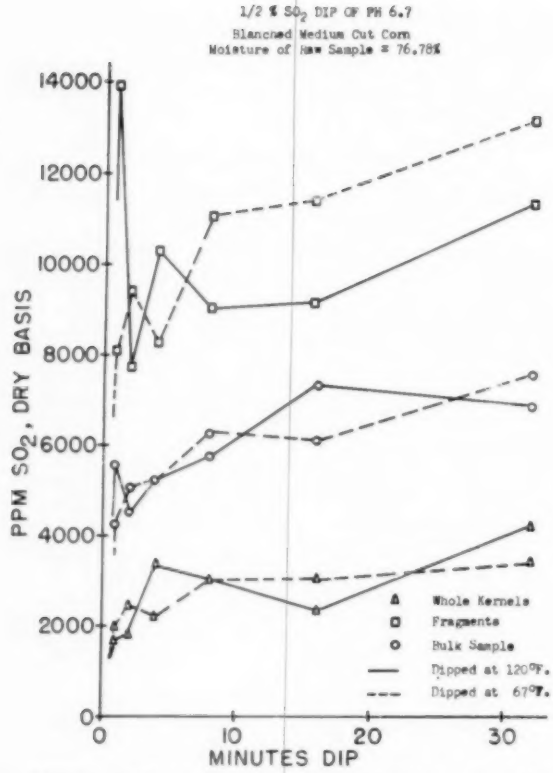

Figure 1. Effect of time of dip and temperature on sulfite uptake by sweet corn.

Figure 4 demonstrates that the margin between the SO_2 uptake by the fragments and by the largest whole entities of the bulk samples varied directly with the depth to which the kernels were cut from the cob. The sulfite pick-up by the bulk samples varied inversely with the depth of cut. Deep cut corn contained a high proportion of whole kernels which absorb sulfite poorly;

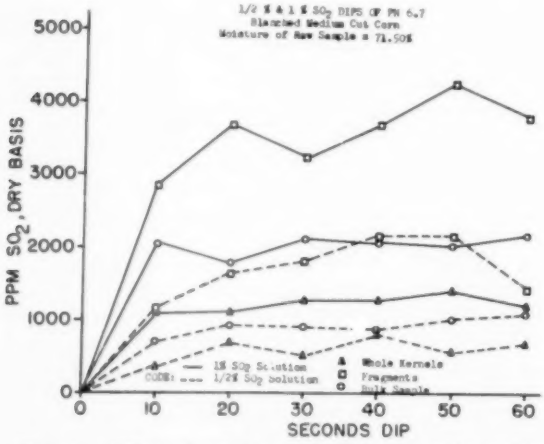

Figure 2. Effect of solution concentration on sulfite uptake by sweet corn during short periods of immersion.

shallow cut corn was high in fragments and smaller particles which adsorb or absorb sulfite to a high degree per unit weight. These observations, together with the data of Table 1, lead to the conclusion that the sulfite content of a bulk sample will depend on the weight ratio of the various sizes of particles within it.

The effect of maturity (as measured by moisture content) of the raw corn on the sulfite uptake by the blanched material is shown for two concentrations of dipping solution in Figure 5. The younger corn took up more sulfite. This may have been due to a difference in sugar contents and membrane characteristics between samples of different degrees of maturity.

Sulfite distribution within kernels after dipping and changes during drying. Figure 6 shows the distribution of sulfur dioxide within kernels of sweet corn immediately after dipping and then after drying to a T of about 0.5. Replicate experiments confirmed the distribution pattern presented. In the whole kernels before dehydration the sulfite content progressively decreased from the base of the kernel or point of attachment, to the crown region. As a result of the initial dehydration

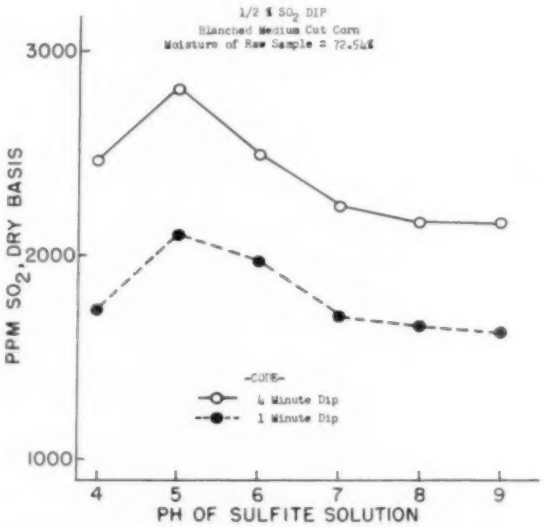
1/2 % SO_2 DIP
Blanched Medium Cut Corn
Moisture of Raw Sample = 72.5%
PPM SO_2, DRY BASIS
PH OF SULFITE SOLUTION
4 Minute Dip
1 Minute Dip

Figure 3. Effect of pH on sulfite uptake by sweet corn.

each section lost a considerable portion of its sulfite content. However, this loss decreased with distance from the cut surface so that the variation in sulfite concentration within the kernel was not quite so marked. In one case samples were prepared from corn which had been held in frozen storage at —40° F. prior to sulfiting. This process resulted in greater uptake of sulfite by the kernels as well as an increase in sulfite contents of the crown regions of the kernel endosperms during drying.

Pathway of sulfite entry into kernels. The finding of a sulfite absorption decrease with an increase in kernel intactness, as shown in Table 1, indicated that the semipermeable membranes surrounding the whole kernel

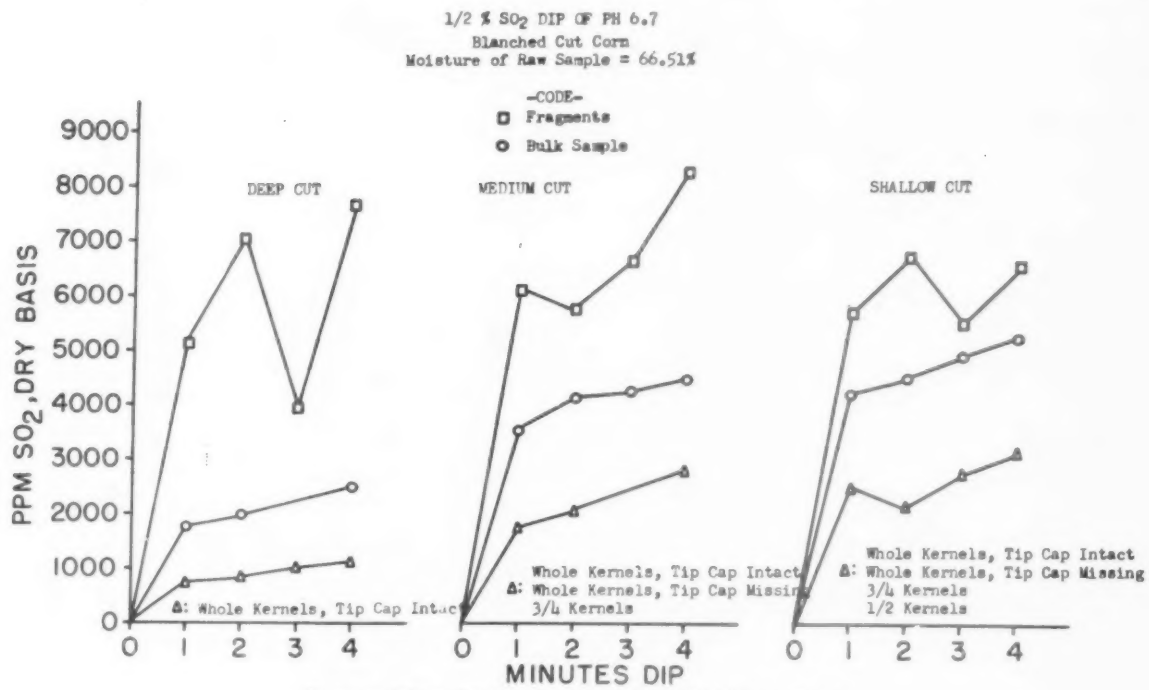

Figure 4. Effect of depth of cut on sulfite uptake by sweet corn.

endosperm are limiting resistances to absorption of sulfite. The results of the distribution study above lead one to conclude that the bulk of sulfite enters the whole kernel through the tip cap, then progresses from the lower to the upper part of the endosperm. A further experiment was carried out to verify this assumption. Sets of kernels were half-immersed in sulfite solution with either the tip cap or crown region dipping into the solution. Table 2 shows that two to three times as much sulfite was picked up via the tip cap region as compared with the crown region of the kernels. Although the kernels were rinsed with fresh water after sulfiting, a later experiment showed that the sulfite picked up by hulls is not readily lost by quick rinses, so that the sulfite values in Table 2 for the crown region probably represent a rather strong sulfite absorption by the pericarp and not necessarily a sulfite penetration into the kernel through that region. These conclusions

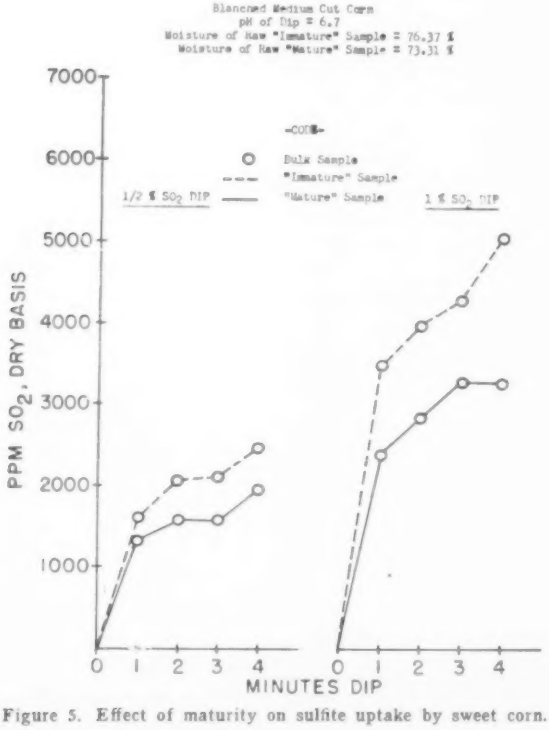

Figure 5. Effect of maturity on sulfite uptake by sweet corn.

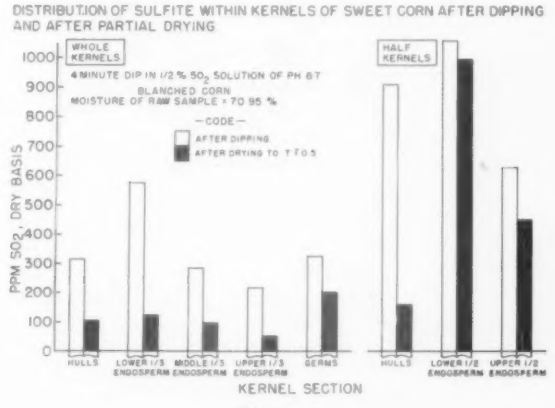

Figure 6

as to the mode of entry of solutes into corn kernels concur with those of Wolf *et al. (5)*.

Effect of puncturing kernels before sulfiting. An attempt was made to ascertain whether a needle puncture through the crown region of the pericarp into the kernel endosperm would permit better sulfite absorption. It was found that punctured whole kernels absorbed more sulfite than unpunctured kernels during immersion in the solution. Dried punctured kernels contained one-half to two-thirds more sulfite than dried unpunctured kernels. The larger the puncture or endosperm opening, the greater the difference in sulfite content between punctured and not punctured whole kernels. Puncturing favored greater proportional absorption by the larger particle than by the smaller ones.

TABLE 2

Uptake of sulfite by blanched whole kernels of sweet corn half-immersed in a ½% SO_2 solution of pH 6.7 for 4 minutes

Run	P.p.m. SO_2 dry basis	
	Tip cap immersed	Crown region immersed
1	300	110
2	230	90

Effect of rinsing after dipping. Rinsing corn samples with fresh water for 10 seconds after sulfiting resulted in the greatest proportional sulfite loss from half kernels. Retention by the free fragments was surprisingly high. The sulfite content of whole kernels was least affected by the rinsing treatment.

The combination of puncturing prior to sulfiting and rinsing subsequent to sulfiting narrowed the sulfite concentration range between the largest particles and the free fragments of a sample to a certain extent. This effect, however, was not believed to be significant enough to warrant further consideration.

SUMMARY AND CONCLUSIONS

Uniform sulfiting of sweet corn from an aqueous salt solution is extremely difficult because of the morphological structure of the corn kernel and other physical characteristics.

When sweet corn is sulfited by dipping in a 0.5 or 1.0% solution most of the sulfite is picked up during the first 10 seconds. Dipping times longer than one minute are not desirable. The difference between the sulfite levels of fragments and of whole kernels within the samples is greatly increased when dipping times longer than one minute are used. Use of dipping solution of greater concentration than 1% further increased the problem of differential uptake of sulfite between fragments and whole kernels. Use of the lowest percent sulfite solution which will give adequate protection during preparation and storage is strongly recommended for treatment of sweet corn.

No effect of temperature of dipping solution was apparent within the limits studied. A pH of 5 appears to be the optimum for the greatest uptake of sulfite from solution.

Sulfite levels within a given sample of dehydrated sweet corn vary from an extremely high level in the fragments to progressively lower levels as groups of more nearly whole sweet corn kernels are examined. Average sulfite level of the sample is directly related to the percentage, by weight, of these various kernel entities.

Within the whole kernel, the sulfite level decreases from the tip cap to the crown. When deep, medium and shallow cut samples are sulfited the average sulfite content increases as the cut becomes shallower. This is due to increased percentages of smaller corn particles in the shallow cut samples.

Immature sweet corn takes up more sulfite than the mature product. Sulfite distribution within the whole kernels is reduced during drying. Proportionally, more sulfite is lost from the lower third or tip cap portion of the kernel than from the middle or the upper third portions.

Blanched, frozen, and defrosted sweet corn takes up more sulfite than the freshly blanched product.

About two to three times more sulfite is taken up through the tip cap end than from the crown section of the sweet corn kernel. The hulls materially reduce sulfite penetration but they tend to strongly hold or bind sulfite.

Puncturing of whole corn kernels prior to treatment tends to increase sulfite absorption. Rinsing of samples after sulfite treatment tends to reduce the difference in sulfite contents between fragments and whole kernels.

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Program of the Vitamin Commission of the International Union of Pure and Applied Chemistry[a]

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The number and variety of foods whose principal nutritive value is due to their content of vitamins is surprisingly large. Many commercially prepared foods are composed in part of high potency ingredients such as fish or other marine liver oils, vitamin A and D concentrates made therefrom, carotene oils, irradiated sterols, dried yeasts, fermentation residues such as riboflavin and vitamin B_{12} concentrates, and of course the synthetic vitamins used for enrichment purposes. These products are bought and sold exclusively on the basis of their vitamin content. In addition there is a large variety of other foods in which the vitamin content plays a decisive role in relation to quality and price. These include milk, butter, and cheese (and their derivatives), margarine, egg and meat products, fresh, canned, frozen, or dehydrated fruits and vegetables, fruit juices, and so on.

Many of these items are the subject of international trade. For the purpose of this discussion it is necessary to remember that a great deal of international trade takes place among foreign countries as well as between them and the United States. Thus, for example, dehydrated rose hips, a rich source of ascorbic acid, have considerably greater importance to certain European countries than they have to the United States.

THE QUESTION OF ASSAY PROCEDURES

The commercial evaluation of food products for their vitamin content demands assay methods that are, above all, specific; they must also be reasonably precise and simple. Many developments have occurred in the methodology of vitamin assays over the past thirty years or so since trading on a vitamin basis commenced. It will be readily admitted by assayers who have had experience with this problem that the precision of these methods has far from satisfied the demands of accounting departments whose capacity for significant figures knows no limit. Nevertheless, substantial advances have been made from the early days when reliance had to be placed exclusively on biological assays. Today, despite the great increase in the number of recognized vitamins, physical, chemical and microbiological tools have displaced the rat from his position of eminence in the court of vitamin jurisdiction. While the rat and the chick still hold sway in the assessment of vitamin D products of relatively low potency, the assay of foods for vitamin content seldom requires the use of animals except for research purposes.

It may seem strange that despite all the importing and exporting of vitamin oils and concentrates over these decades, no formal action in the direction of international agreement on assay procedures has ever been attempted. The natural forces of commerce seem to have prevailed; that is to say, in a buyers' market the buyers' choice of assay procedure is usually specified, whereas in a sellers' market the seller dictates the terms. This rule has mostly worked in favor of buyers in the United States since we have more often been the importing country. Moreover, official standardization of vitamin assays has been developed in the United States to a greater extent than in most foreign countries. The official status accorded to such compendia as the U. S. Pharmacopeia *(4)* and the Book of Methods of the Association of Official Agricultural Chemists *(2)* has been a strong motivating force in this direction. However, it must be recognized that pharmacopeial organizations and standards-making agencies exist in other countries as well.

Even after the parties to a transaction have reached agreement on the choice of the assay method to be employed in evaluating a given vitamin product, disagreements are not infrequently encountered between the laboratories representing the buyer and seller, respectively. Variations are attributable to technical details, such as the quality or choice of reagents, differences in instrumentation, instability of electric current, or to environmental factors like the temperature, humidity, or light conditions. Failure to conform literally to specified analytical procedures or the use of different standards of reference are also contributory causes of interlaboratory discrepancies.

In intranational trade recourse is often had to official methods. Even in the absence of contractual declaration of the procedures to be applied in any given commercial transaction, these official methods may be assumed to have standing in the courts. But this is not the case with respect to international transactions. Hence disputes have arisen either because of failure to recognize that official international methods do not exist or through failure to specify which method shall apply in a particular transaction.

Establishment of the Commission. Recognizing that trade in food products would be facilitated if international agreement could be reached on the details of analytical or assay methods, the Food Division of the Applied Chemistry Section of the International Union of Pure and Applied Chemistry, has undertaken to achieve this objective. Since it was thought that the need for international agreement on methods for vita-

[a] Presented before the Fifteenth Annual Meeting, Institute of Food Technologists, Columbus, Ohio, June 14th, 1955.

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mins was more acute than for other types of food analyses, one of the first acts of the Food Division was to establish an International Vitamin Commission. The members and their affiliations are:

Professor E. Brunius (Chairman), Vitamin Department, National Public Health Institute, Tomteboda, Stockholm, Sweden.

Dr. W. F. J. Cuthbertson, Glaxo Laboratories Ltd., Greenford, Middlesex, England.

Dr. Max Kofler, F. Hoffmann-La Roche & Co. Ltd., Basle, Switzerland.

Dr. Bernard L. Oser, Food Research Laboratories, Inc., 48-14 Thirty-third Street, Long Island City 1, New York, U. S. A.

Docteur Henri Simonnet, Member, National Academy of Medicine, Professor, National Veterinary School of Alfort and National Institute of Agronomy, 9, Rue de la Cite Universitaire (XIV), Paris, France.

The activities of the Commission are conducted mainly by correspondence. However an initial meeting was held in London in December 1954, and another in July, 1955, in connection with the XIVth International Congress of Pure and Applied Chemistry in Zurich. Several months before the writer left for Europe to attend the first meeting of the Commission several conferences were held with specialists in the field of vitamin A assay. These, together with the conferences conducted in 1954 under the auspices of the USP Revision Committee, served to provide useful background material as to the current status of vitamin A standardization in this country.

Some basic principles and objectives. Several basic principles have been agreed upon by the membership of the Commission. It will not concern itself with vitamin products developed or intended for use in pharmaceutical preparations. This is the province of the various national pharmacopeial organizations and of the Expert Committee on the Unification of Pharmacopeias established by the World Health Organization. Although pharmacopeial methods are frequently employed as the basis for the assay of vitamins in foods, they have no official status in the food and feed fields except when they are specifically so adopted. This has been done in the case of various vitamin assay methods of the Association of Official Agricultural Chemists *(2)* or the Association of Feed Control Officials *(3)*.

The Vitamin Commission recognizes that it has no enforcement powers. Any assay procedure recommended and promulgated by the Commission will have only the degree of authority commensurate with its international backing.

The Commission does not propose to enter into the development of vitamin assay methods de novo. It is recognized that a vast amount of useful work has been accomplished in this area already. The aim of the Commission will be to adopt the features of these methods which in the experience of the members of the Commission best satisfy the combined requirements for specificity, reproducibility, simplicity, and workability on an international basis.

It is recognized that for trading purposes specificity or accuracy has often been sacrificed by more or less tacit agreement of the parties to a transaction when, in order to achieve it, a commercially untenable degree of imprecision would result. For example in assessing vitamin A potency of fish liver oils, whole oil spectrophotometric absorption values were used at a time when the only truly accurate method of evaluating vitamin A potency was the biological assay. In view of the cost of bioassays in terms of time and money, as well as the large error of the biological assay, it seemed inevitable that efforts would proceed in the direction of making the more reproducible chemical and physical methods for vitamin A as reliable as possible rather than in the direction of increasing the precision of the bioassay. The successful culmination of this trend was seen in the replacement of the rat growth assay for vitiamin A in the U. S. Pharmacopeia and other compendia by a spectrophotometric assay based on the ultraviolet absorption of the unsaponifiable extract and correcting for non-specific absorption by an improved method originally proposed by Morton and Stubbs *(1)*.

ACTIVITIES OF THE VITAMIN COMMISSION

In the year or so of its existence the Vitamin Commission has been concerned principally with the assay of marine liver oils and vitamin A concentrates. The methods for the assay of vitamin A employed in various countries have been discussed critically with a view toward combining their best features and at the same time deviating as little as possible from the most generally accepted practice.

To this end it has been agreed that the assay should be based on the ultraviolet absorption of the vitamin using the saponification and extraction procedure substantially as described in the U. S. Pharmacopeia. This decision was arrived at after careful discussion of such factors as the volume of solvent in relation to oil, concentration of alkali, time and temperature of refluxing, etc. In view of the fact that isopropanol of suitable purity is not available in certain European countries and that absolute ethanol (not denatured) is a heavily taxed luxury in many American laboratories, it was decided to explore the possibility of recommending the alternative use of either of these solvents. Since present data were considered to be inadequate as a basis for deciding on this point, a collaborative experiment was agreed upon as a means of obtaining the necessary support for this proposal. The collaborative study was begun last spring, the first step being the preparation and capsulation of a standard solution of vitamin A acetate from a composite of three batches of crystalline all-trans vitamin A acetate prepared in three different countries and checked to establish their spectrophotometric uniformity.

The data from this collaborative study will be used to establish whether, within the limits of error, the extinction ratios E_{310}/E_{325} and E_{334}/E_{325} have the same value in both isopropanol and absolute ethanol. They will also provide data for checking the constants entering into the correction formula specified by the U. S. Pharmacopeia. Incidentally, data will also be ob-

tained on the reproducibility of the extinction ratios among the collaborating laboratories and on the degree of vitamin A loss encountered in the saponification and extraction procedures.

Before the correction formula can be applied in the assay, it is proposed that the vitamin A absorption curve of a test material satisfy certain criteria. Accordingly, vitamin A-bearing oils and concentrates will be considered as falling into two categories, the first comprising those whose unsaponifiable extracts have absorption maxima within the region *323-327* mμ (the terminal wavelengths being included), and extinction ratios E_{300}/E_{325} not exceeding 0.7. (The latter figure may be subject to some minor change before final adoption.) The second category would comprise products whose unsaponifiable extracts have absorption maxima outside the above range, *323-327* mμ, and/or extinction ratios exceeding 0.7. For products in the first category, a correction formula similar to or identical with that of U. S. Pharmacopeia XIV (now XV) would be applied, provided the results of the collaborative study described above so warrant. The possibility exists that different equations may be required depending on whether isoproponal or ethanol is used as the solvent.*

Vitamin A products belonging to the second category would have to be subjected to further purification of the unsaponifiable extract by means of chromatographic adsorption. The procedure presently described in the Swedish Pharmacopeia appears to be most adaptable to this purpose although as yet no decision has been reached in this connection.

Vitamin A chromatography. The Commission recognizes that much remains to be done in the field of standardizing adsorbents for vitamin A chromatography and is cognizant of efforts in this direction currently under way in the United States. A special working group under the auspices of the Commission is exploring this matter further. It is planned to inaugurate a subsequent collaborative experiment in which the reproducibility of the procedure outlined for products subject to chromatography will be investigated.

After correction of vitamin A absorption curves which have satisfied the criteria for spectral purity described above, the recommendation will be to multiply the $E^{1\%}_{1cm.}$ 325 mμ value by the factor 1830 to obtain International Units of vitamin A per gram. If the requirements for spectral purity are not satisfied, even after chromatographic fractionation, it will be recommended that the vitamin A product be assessed biologically.

In considering the magnitude of the fiducial limits for the spectrophotometric vitamin assay, it was agreed, in accordance with the experience of analysts in the United States, that the error of a single assay based on the unsaponifiable extract (but not including chromatography) is ± 8 percent at the 95 percent probability level. It is hoped that the results of the collaborative study of the method for products falling into the second category will yield a basis for estimating its error also. In any event it was agreed that while fiducial limits or standard errors should not be stated on assay reports, the parties to a commercial transaction should be advised to agree in advance upon the steps to be taken in the event that their respective assay values differ by more than a specified degree.

Vitamin assay methods for foods or feeds. No action was taken by the Commission with respect to the recommendation of vitamin A assay methods for foods or animal feeds. Certain questions must be resolved before a decision can be reached as to whether to approach this subject from the point of view of ultraviolet absorption or the antimony trichloride procedures. A working group has been established to consider this problem further.

A special report on methods for the assay of vitamin D was presented to the Commission by Dr. W. F. J. Cuthbertson, the member representing Great Britain. There was general agreement on the principles involved in his recommendations which are aimed at defining the conditions of the rat and chick assays broadly so that investigators can use their customary diets and methods of maintenance, dosage, etc. provided that certain basic conditions are complied with. Emphasis is placed on the statistical design of the assay so as to permit estimates of potency rather than simply minimum values, and to establish the validity and fiducial limits of an assay on the basis of internal evidence. These recommendations have not yet been officially considered by the Vitamin Commission but a working group has been assigned to the problem. It is of interest to note that the recently adopted vitamin D assays in the U. S. Pharmacopeia XV also provide for improved statistical design involving the use of two reference groups and one or two assay groups.

AIM OF THE COMMISSION

This discussion of the *modus operandi* of the Commission with respect to one particular vitamin assay will serve to indicate the seriousness of its purpose and the care and deliberation employed in executing it. While the Commission has no intention, nor indeed any authority, to supplant existing national or international standards-making agencies, it seems likely that its efforts will fill a long-existing gap in international trading relations where vitamin products are involved.

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* The results of the collaborative study available at the July 1955 meeting, though not complete, warranted the recommendation that only isopropanol be used.

The Effect of Herbicide Karmex-W on the Flavor of Canned and Frozen Asparagus[a, b]

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(Manuscript received June 21, 1955)

As a routine part of the tests on any new pesticide, requests for flavor evaluations of foods derived from crops to which the pesticide has been applied are submitted to the Food Technology Department of the New Jersey Agricultural Experiment Station by other departments. In this instance the test chemical under study was the herbicide, Karmex-W, which had been applied to fields of asparagus by the Vegetable Crops Department. The purpose of this preliminary investigation was to ascertain whether or not Karmex-W (3-p-chlorophenyl-1,1-dimethyl urea) produced a flavor effect in canned and frozen asparagus. On the basis of the field tests and the flavor evaluation results, plans were formulated for further work on Karmex-W.

Washington strains of asparagus were grown on fields treated with Karmex-W. Samples of asparagus from treated and untreated plots were submitted for processing and subsequent flavor evaluation.

Two asparagus fields, each about one acre in area and three years old, were used as test plots. The soil type was Evesboro sandy loam. There had been no herbicide used on the plots previously. Rotenone had been used to control insects when and where needed. The asparagus for freezing was harvested from one field and that for canning from the second.[c]

EXPERIMENTAL

Frozen asparagus. On April 22, 1954, prior to spear emergence, a standard formulation of Karmex-W (80% W.P.) was sprayed on half of the field at a rate of 2 pounds per acre. The unsprayed half of the field served as a control. Asparagus harvesting started April 27 and continued at weekly intervals through June 14, 1954.

The asparagus was prepared for freezing and frozen the day after the harvest in the following way:

1. Washed first by soaking and then by running water. (Washing time was dependent on the amount of dirt on the asparagus.)
2. Trimmed and cut into pieces.
3. Blanched the tips 1½ minutes and the cuts 3 minutes in boiling water.
4. Cooled the asparagus in running water.
5. Packed it into 10 ounce packages overwrapped with heavy waxed paper.
6. Frozen at —10° F. and held in frozen storage at —10° F.
7. Flavor evaluations were started September 27, 1954, and they were completed on October 13, 1954.

Canned asparagus. On June 1, 1954, a standard formulation of Karmex-W (80% W.P.) was sprayed at a rate of 2 pounds per acre to one half of a second asparagus field. The other half was used as the control. Asparagus had emerged at the time of the treatment. Harvests of asparagus were made on June 1, 2, 3, 4, 7, and 14, 1954.

The following procedure was used by Department of Food Technology personnel in canning the asparagus the day after harvest:

1. Washed first by soaking and then in running water. (Washing time varied with the amount of dirt on the asparagus).
2. Cut into pieces.
3. Blanched the tips 1½ minutes and the stalks 3 minutes.
4. Filled into plain tin cans, added ½ teaspoon of salt per can, and filled the can with boiling water.
5. Sealed under 15 inch vacuum.
6. Processed for 3 minutes at 240° F., using 70° F. as the initial temperature.
7. Cooled under running water.
8. Stored at room temperature.
9. Started flavor evaluations on October 15, 1954, and completed them October 25, 1954.

Commercially canned asparagus. Samples of asparagus, some treated with Karmex-W and some untreated, were submitted for flavor evaluation. The asparagus had been harvested from the beds that were either 18 or 19 years old. The asparagus had been canned according to standard commercial practice by a large canner.

The asparagus had been harvested at the following intervals: May 6, 8, 9, 10, 12, 13, 14, 20, and 27, 1954. Flavor evaluations were made after 6 months of storage, starting November 1 and continuing through November 19, 1954, and again after 9 months of storage, beginning on February 2 and concluding on February 21, 1955.

FLAVOR EVALUATION

The panel which had been in existence for 4 years was made up of graduate students and staff members of the Department of Food Technology. The panel had not been trained on any one commodity, but rather had had diversified experience in evaluating flavor differences on about 25 different fruits and vegetables. In most instances the problem to be considered was whether or not pre-harvest treatment with new pesticides produced a difference in flavor in the food ma-

[a] Paper of the Journal series, New Jersey Agricultural Experiment Station, Rutgers University, the State University of New Jersey, Department of Food Technology, New Brunswick.

[b] Presented before the Fifteenth Annual Meeting of IFT, Columbus, Ohio, June 14, 1955.

[c] D. J. H. Ellison, associate research specialist in vegetable crops, and Dr. R. J. Aldrich, assistant research specialist in vegetable crops, applied the field treatments and harvested and delivered the asparagus for processing.

terial being evaluated, as compared with the normal control program.

Flavor evaluations were made using the triangle test technique. In this series of tests the triangle test was the logical choice since there was a treated and an untreated sample for each harvest day. Each judge received three coded samples on a divided plate; two samples were alike, whereas one was different. The judge was asked to indicate the duplicate samples on the score sheet. Two triangle tests were made on each harvest of asparagus by each judge. The samples were rerandomized for each replicate triangle test.

Asparagus which had been frozen was cooked and served hot to the panel. Canned asparagus was served at room temperature.

The panel judgments on each set of samples were analyzed statistically to ascertain whether or not a flavor difference was detectable.

Results are presented in Tables 1-4, inclusive.

TABLE 1

Frozen asparagus—five months' storage

Harvest date 1954	A flavor difference between the Karmex-W treated sample and the control was:	Number of judgments	Number of correct separations
April 27	Not detectable	16	6
May 4	Not detectable	14	4
May 11	Not detectable	18	9
May 18	Not detectable	16	9
May 25	Detectable*	18	10
June 1	Detectable*	14	9
June 7	Not detectable	16	7
June 14	Not detectable	16	7

* Significant at 0.05 level.

TABLE 2

Canned asparagus [1]—five months' storage

Harvest date 1954	A flavor difference between the Karmex-W treated sample and the control was:	Number of judgments	Number of correct separations
June 1	Not detectable	14	4
June 2	Not detectable	16	7
June 3	Not detectable	14	6
June 4	Not detectable	12	1
June 7	Not detectable	14	3
June 14	Not detectable	16	7

[1] Canned by the Department of Food Technology, Rutgers University.

TABLE 3

Commercially canned asparagus—six months' storage

Harvest date 1954	A flavor difference between the Karmex-W treated sample and the control was:	Number of judgments	Number of correct separations
May 6	Not detectable	12	4
May 8	Not detectable	14	5
May 9	Not detectable	14	6
May 10	Not detectable	14	4
May 12	Not detectable	14	5
May 13	Not detectable	10	2
May 14	Not detectable	12	5
May 20	Not detectable	20	7
May 27	Not detectable	15	3

TABLE 4

Commercially canned asparagus—nine months' storage

Harvest date 1954	A flavor difference between the Karmex-W treated sample and the control was:	Number of judgments	Number of correct separations
May 6	Not detectable	16	7
May 8	Not detectable	26	10
May 9	Not detectable	20	9
May 10	Not detectable	22	11
May 12	Detectable**	24	15
May 13	Detectable*	18	10
May 14	Detectable**	26	15
May 20	Not detectable	20	8
May 27	Not detectable	18	9

* Significant at the 0.05% level.
** Significant at the 0.01% level.

SUMMARY OF RESULTS

After five months of storage, flavor differences were found in only two samples of frozen asparagus—that harvested on May 25 and June 1. No flavor differences were found in the canned asparagus (Department of Food Technology) at the end of 5 months' storage. At the end of 6 months' storage, no detectable flavor differences were found in the commercially canned samples. After 9 months' storage, however, commercially canned asparagus samples harvested on May 12, May 13, and May 14 had detectable flavor differences. Apparently, in some samples a different flavor developed during storage.

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The Influence of Ripeness on the Organic Acids, Sugars, and Pectin of Canned Bartlett Pears

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Bartlett pears were ripened to different pressure tests and canned according to commercial procedures. Organic-acids analyses of these samples were made by silica-gel column and paper chromatography. Results indicate malic and citric are the acids present in major concentration in canned Bartlett pears. Ripening at 68° F. (20° C.) is accompanied by a rapid decrease of malic acid and a slower decrease of citric acid. Several acids present in lower concentration were identified by chromatographic procedures. The presence of glucose, fructose, and sucrose was also established by paper chromatographic methods. As ripening progresses, protopectin decreases and soluble pectin increases. The intrinsic viscosity and neutral equivalent of the versene-extracted pectin decreases as pears ripen, indicating glycosidic hydrolysis by polygalacturonase and de-esterification by pectin-esterase. The influence of these constituents on flavor and texture of the canned pears is discussed.

The relation of maturity and handling of Bartlett pears to quality of the canned product was reported in 1934 by Ezell and Diehl *(9)*. Recently, Leonard *et al. (19)* showed that the flavor of canned Bartlett pears largely depends on proper ripeness of the the fresh fruit. In the former study chemical analyses were conducted mainly on fresh fruit, while in the latter the canned product was also used. Both groups reported that a decrease in total titratable acidity and an increase in soluble solids accompany ripening. Leonard *et al. (19)* found a further increase in total titratable acidity in pears during the later stages of ripening, but the nature of such change was not investigated.

In general, pears are relatively low in acid. Strachan and co-workers *(29)* found that Bartletts have the highest acidity and lowest pH among six varieties of pears grown in British Columbia. Malic and citric acids are present in relatively large concentrations in pears *(14, 24)*, but the percentage of each varies with the variety. The acids present in low concentration in pears have not been thoroughly investigated, nor have the changes in individual organic acids accompanying ripening been followed. The changes in sugars during storage and ripening of fresh pears have been investigated *(1, 9)*, but little work has been done on identification of the individual sugars.

The study reported on here was part of a project to relate the changes in composition occurring during ripening to the quality of the canned product. Two series of samples with different average pressure tests were canned—one in distilled water and one in 25° Brix sucrose syrup. Chemical properties of the canned pears were correlated with ripeness of the fresh fruit as measured by pressure test. The influence of ripeness on the organic acids, sugars, and pectin of the canned Bartlett pears is discussed.

EXPERIMENTAL

Harvesting and handling procedures. Bartlett pears used in this investigation were harvested in Lake County, California, at 16 to 18 pounds pressure test on September 2, 1953, and on August 10, 1954. The fruit was stored at 32° F. (0° C.) and 85% relative humidity for 7 days during the 1953 season and for 20 days during the 1954 season. Following cold storage the pears were ripened at 68° F. (20° C.) and 85% relative humidity.

The pears were canned at different stages of ripeness, as indicated by change in pressure test. During the 1953 season the average pressure tests for each lot were established by testing 20 pears selected at random. This procedure was modified during the 1954 season and each pear was pressure tested before being canned; only fruits testing within one-half pound of the desired pressure test were used.

During both seasons the pears were sorted to remove defective fruit, washed in distilled water, and wiped dry. Each fruit was halved, cored by hand, and packed into No. 2½ cans. Each can contained 18 ounces of unpeeled fruit and 11 ounces of distilled water. Similarly, a series of peeled and halved pears was canned in 25° Brix sucrose syrup. The peeled pears were submerged in tap water for 3 to 5 minutes before syruping to minimize enzymic browning. The cans were exhausted in a vacuum closing machine and sealed under 15 inches of vacuum, processed in a rotary cooker at 212° F. (100° C.) for 30 minutes, and then cooled rapidly in cold water for 7 minutes.

Chemical analysis. The 1953 pack was stored at room temperature for 10 months before analysis, and the 1954 pack for 4 months. The contents of 5 cans of water-packed pears selected at random from each lot were thoroughly mixed in a Waring blender. The slurry thus obtained was analyzed for soluble solids, total titratable acidity, and total solids, as described in a previous paper *(19)*, and for organic acids, sugars, and pectin.

Lyophilization of the sample. One hundred g. of slurry was weighed into an enamel pan and lyophilized for 48 hours in a Stokes Freeze Drier under a pressure ranging from 50 to 150 μ of Hg. The weight of the slurry represented by 1 g. of lyophilized pulp was determined. The dried residue was stored at 10° F. (−12° C.) in tightly sealed glass bottles.

Malic and citric acids. A 1,000-g. sample of the lyophilized product of the 1953 water-packed series was mixed with 1 g. of silicic acid powder. The mixture was acidified with 0.1 ml. of 5N H_2SO_4 and transferred quantitatively to a prepared silicic acid column, 15 mm. i.d. and 25 cm. long. Because of the low acid content in the 1954 water-pack series, the amount of pear powder, silicic acid, and 5N H_2SO_4 was doubled. Generally, the column, solvents, and indicator were prepared in the manner described by Bulen *et al. (5)* with the following exceptions: (a) the column was made from 15 g. of dried silicic acid powder which was mixed with 10 ml. of 0.5N H_2SO_4; and (b) instead of nitrogen gas, compressed air freed from carbon dioxide by bubbling through 6N NaOH was used to maintain a slight, but constant, pressure on the column.

Air pressure was adjusted to collect about 60 ml. of effluent per hour. The schedule of solvents used in developing the column was 100 ml. of 30% *n*-butanol in chloroform followed by 500 ml. of 35% *n*-butanol in chloroform (v/v). The first 150 ml.

of effluent was discarded. Fractions of 5 ml. each were collected in 10-ml. pyrex test tubes by an automatic constant volume fraction collector. Each fraction was poured into a 125-ml. Erlenmeyer flask. The tube was rinsed twice with 10-ml. portions of carbon dioxide-free water. The fraction and the washings were combined and titrated with 0.01*N* NaOH from a microburette, using one drop of 0.1% phenol red as an indicator. Vigorous agitation of the flask was necessary during the titration to insure the extraction of the acids into the water layer. Each titration was corrected for the blank reading. The quantities of malic and citric acids were reported as milliequivalents (meq's) of acid per 100 g. of pear sample on a dry basis.

Other organic acids. Organic acids present in minute concentrations in the canned pears were separated by silicic acid column chromatography of the lyophilized powder and also of an alcohol extract of the canned pears. A large chromatographic column 22 mm. i.d. and 40 cm. long was used. The column was prepared with 32 g. of silicic acid and 20 ml. of 0.5*N* H_2SO_4. Four g. of the lyophilized powder from the 2.1-pound pressure series was mixed with 4 g. of silicic acid, acidified with 4 ml. of 0.5*N* H_2SO_4, and developed successively with 150 ml. of 5%, and 100 ml. each of 10, 15, 20, and 30% *n*-butanol in chloroform (v/v). Five-ml. fractions were collected and titrated as previously described. Fractions believed to contain one specific acid as determined by titration were combined, evaporated to dryness in a stream of air, and paper chromatographed.

To obtain these acids in greater concentration, 800 g. of slurry, prepared from a sample canned at 2.1 pounds pressure test, was mixed with 800 ml. of 95% ethanol, centrifuged, and the alcohol extract decanted. The residue was again extracted with 400 ml. of 80% ethanol. This procedure was repeated twice. The combined alcohol extracts were evaporated to dryness under a hood at room temperature.

The dried extract was dissolved in 100 ml. of distilled water and then passed through a Duolite C-3 cation exchange column in the hydrogen form to remove metallic ions. The column was washed with 100 ml. of distilled water to recover all the free acids. The acids were then adsorbed on a Duolite A-4 anion resin column in the hydroxide form. The column was washed with 500 ml. of distilled water to remove sugars. The acids were recovered from this column with 200 ml. of 2*N* NH_4OH. The effluent was then passed through a Duolite C-3 column to convert the ammonium salts to the free acids. This column was washed with 100 ml. of distilled water to recover all of the acids. The effluent and washings were combined and evaporated to dryness by air draft at room temperature.

The organic acids were resuspended in 2 ml. of water. One ml. of the resulting solution was mixed with 1 g. of silicic acid, which, after acidification, was developed on the column containing 15 g. of silicic acid with the solvent described previously. Fractions from the same titration peak were combined, evaporated to dryness as previously described, and used for paper chromatography.

Identification of acids. Organic acids were identified by uni-dimensional descending paper chromatography. A few drops of distilled water were added to the dried acid samples isolated from the silicic acid column. A 0.01-ml. aliquot of the sample was applied to a Whatman No. 1 filter paper. The same quantity of known acid solution containing 100 μg. of acid was applied adjacent to the unknowns. Two developing solvent mixtures were used: (a) *n*-butanol-water-90% formic acid (5:4:1 v/v) *(3)*, and (b) phenol-water-90% formic acid (300:100:4 w/w) *(28)*. Solvent (a) was prepared 8 hours before use, and only the top layer was used. Chromatograms were developed for 16 to 18 hours at 70° F. (21° C.).

Chromatograms were sprayed with a 0.04% solution of bromophenol blue in 95% ethanol at pH 5.8. When the phenol solvent was used to develop the chromatogram, some spots were placed halfway down the paper to prevent the phenol front from obscuring the very slow-moving acid spots *(28)*.

Sugars. The sugars present in the canned product were identified by unidimensional descending paper chromatography. Sugars were extracted from pear samples by a procedure similar to that described by Griffith *et al. (11)*, which is briefly as follows: 50 ml. of 80% ethanol was mixed with 2 g. of lyophilized pear powder for 2½ hours with frequent stirring. The mixture was filtered and the residue washed with 50 ml. of 80% ethanol. The alcoholic extract and washings were combined and evaporated to approximately 2 ml. under a hood at room temperature. To remove cations and organic acids, small quantities of Duolite C-3 and A-4 were added to the solutions. After 2 to 3 hours, the resins were removed by filtration and washed with distilled water. The filtrate and the washings were combined and made up to 125 ml. with distilled water.

Approximately 0.03 and 0.06 ml. of each sample was spotted on Whatman No. 1 filter paper adjacent to 0.01-ml. aliquots containing 50 μg. of known sugars. The developing solvent was propanol-ethanol-water (7:1: 2 v/v) *(27)*. Chromatograms were developed for 30 to 36 hours at 70° F. (21° C.), dried, and then sprayed with a solution containing 0.5 g. benzidine, 10 ml. glacial acetic acid, 10 ml. 10% trichloroacetic acid, and 8 ml. of absolute ethanol *(27)*. The papers were then baked in an oven at 200° F. (93° C.) for 10 minutes. Sugars appear as brown spots on a light background.

Both slurry and lyophilized powder were analyzed for reducing and non-reducing sugars by the modified Hassid method *(12)*. Reducing sugars are reported as dextrose equivalents (DE) by comparison with a standard glucose solution. The increase in reducing value after inversion was calculated as sucrose.

Pectin. Methods used to separate the pectins into water-soluble and versene-soluble fractions were essentially the same as those described by Owens *et al. (25)*. The pectic materials were reprecipitated from each fraction by adding 2 volumes of 95% ethanol *(20)*. Uronide content was determined by the carbazole method described by McCready and McComb *(22)*. Intrinsic viscosity of the versene-extracted pectin was determined by using Ostwald viscosimeters at 25° C. *(20)*. Pectin solutions at pH 6.0 in 0.8% sodium chloride and 0.2% Calgon were used in this determination *(25)*.

RESULTS

Changes in organic acids with maturation of Bartlett pears. A preliminary investigation using paper chromatography revealed that the only two organic acids present in significant quantity in canned Bartlett pears were malic and citric. These acids were determined quantitatively by silicic acid column chromatography. The results obtained as they relate to the pressure test of the fresh fruit are shown in Figures 1 and 2.

In Figure 1, the sample with the pressure test of 16.8 pounds was picked and canned one week before the harvest of the control-ripened pears. This sample had a higher malic, citric, and total titratable acidity than the sample harvested at 16.5 pounds. The pressure test of the pears harvested at 16.5 pounds decreased to 14.4 pounds after a week's storage at 32° F. (0° C.). When pears were ripened at 68° F. (20° C.) to a pressure test below 5.5 pounds, malic acid decreased rapidly, citric more slowly. Both acids appeared to reach a minimum value when the average pressure test was 1.5 pounds. Further ripening seemed to be accompanied by an increase in the two acids.

This experiment was repeated on the same series of pears canned in 25° Brix sucrose syrup. The results were similar to those obtained for the samples canned in distilled water.

During the ripening of the fruit a correlation between total titratable acidity and the sum of the malic and citric acids was apparent until the pressure test decreased to 2.4 pounds. Below that point, the titratable acidity increased, while both malic and citric acids were still decreasing. An increase in other acids may have contributed to the increase in titratable acidity. Quantitative changes in these acids were not followed, however. Another possible contributing factor might be the increase of galacturonic acid or oligogalacturonides arising from de-esterification of the methyl ester groups in the pectin molecule by the action of the enzyme pectin-esterase *(33)*.

During the 1954 season the experiment was repeated, and the results (Figure 2) are in general agreement with the 1953

data. However, samples with pressure tests below 1.6 pounds were not canned during 1954, and the possible increases in malic and citric acids noted during the last stage of ripening in the 1953 samples were not observed. It is interesting to note that the pears canned in 1954 contained only about half as much acid as

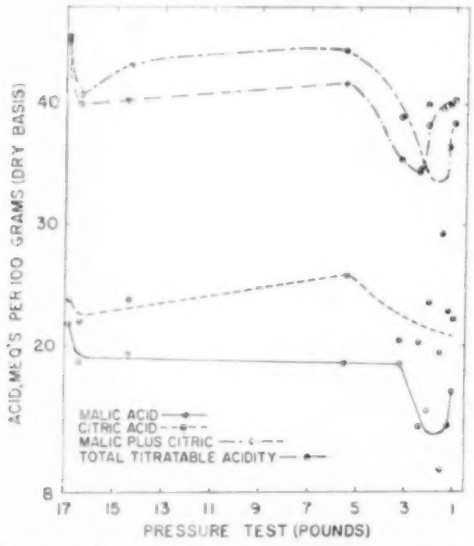

Figure 1. Changes in acid contents of Bartlett pears canned at different pressure tests (1953 water pack).

the 1953 pack. This was probably due to variations in climatic conditions and possibly to changes in cultural practices.

Results of both years' analyses indicated that the total titratable acidity was lower than the sum of malic and citric acids, indicating the presence of both malate and citrate ions in addition to the free acids in the pears.

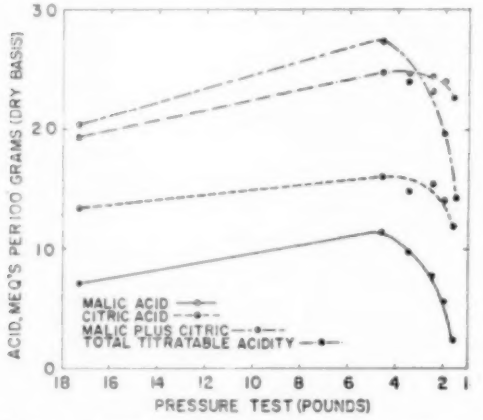

Figure 2. Changes in acid content of Bartlett pears canned at different pressure tests (1954 water pack).

Identification of acids by paper chromatography. The organic acids present in very low concentrations in canned Bartlett pears were separated from malic and citric acid by silicic acid column chromatography of both the lyophilized powder and concentrated alcohol extract. The presence of the various acids was demonstrated by paper chromatography. Only the sample canned at an average pressure test of 2.1 pounds was used for this investigation. Samples of known organic acids were converted to their sodium salts for comparison on the paper chromatogram.

Development of the paper chromatograms with the epiphase of a solvent mixture made from *n*-butanol-water-90% formic acid (5:4:1 v/v) followed by spraying with bromophenol blue indicator, indicated the presence of chlorogenic, alpha-keto-glutaric, glycolic, and possibly pyruvic, succinic, and lactic acids in canned Bartlett pears. The Rf values of the various acids are shown in Tables 1 and 2.

TABLE 1

Rf values determined for the sodium salts of known acids used for identification

Known acids	Solvent		
	n-butanol-water-90% formic acid [1]	phenol-water-90% formic acid [2]	
		spotted at top	spotted half way
Chlorogenic	.55	.56	.78
Glycolic	.62	.53	.66
alpha-keto-glutaric	.67	—	.51
Tricarbolyllic	.70	—	—
Lactic	.74	.75	.80
Succinic	.74	.68	.80
Pyruvic	.74	.66	.80
Fumaric	.85	—	—

[1] 4:5:1 (v/v).
[2] 300:100:4 (w/w).

Because of the failure to separate pyruvic, succinic, and lactic acids with the solvent mixture of *n*-butanol-water-formic acid, it was decided to use a mixture of phenol-water-90% formic acid (300:100:4 w/w) as recommended by Stark *et al. (28)* and Rentschler and Tanner *(26)*. The results, along with Rf values for the two different spotting procedures used, are also presented in Tables 1 and 2. The chlorogenic acid spots fluoresced under ultra-violet light and turned dark green when exposed to ammonia fumes, which is in agreement with the work of Bradfield *et al. (4)* and Hulme and Richardson *(13)*. Weurman and Swain *(35)* have shown that chlorogenic acid is one of the substrates involved in enzymatic browning of pears. Chlorogenic acid was not detected by the alcohol extraction method.

TABLE 2

Rf values of the sodium salts of unknown acids from pears

Solvent for silica-gel column	Solvent for paper chromatography		
% *n*-butanol in chloroform (v/v)	*n*-butanol-water-90% formic acid (4:5:1 v/v)	phenol-water-90% formic acid (300:100:4 w/w)	
		spotted at top	spotted half way
10	.74 (pyruvic)	.66 (pyruvic)	.80 (pyruvic)
15 and 20	.55 (chlorogenic) .66 (alpha-keto-glutaric) .73 (lactic or succinic)	.55 (chlorogenic)	.51 (alpha-keto-glutaric) .77 (chlorogenic)
25	.62 (glycolic) .74 (lactic, succinic)	—	—

The first acid eluted from the silicic acid column by the 5% *n*-butanol solvent was greenish in color and strongly acidic. It was soluble in chloroform but insoluble in water and could not be identified by paper chromatography. It left a greasy coating on the bottom of the beaker when concentrated and was not found in the alcohol extract.

The second acid which emerged from the column in the 5% *n*-butanol solvent gave a sharp increase in titration value. Of the acids occurring in low concentration this was present in the greatest quantity, yet it could not be detected by paper chromatography. Volatility would account for this behavior. Acetic

acid was found to emerge from the column in the 5% *n*-butanol solvent by Bulen *et al. (5)*. Thus, this acid might be acetic.

Identification of the various other organic acids by paper chromatography was in agreement with the solvent concentration and position in which the acids would elute from the silicic acid column. The presence of still other acids was indicated, but sufficient quantities could not be isolated for identification.

Chromatography of sugars in pears. The results of chromatographic identification of various sugars present in Bartlett pears canned in distilled water are shown in Table 3. In a preliminary experiment, glucose and fructose were the only sugars found in large quantity. Presence of sucrose was indicated after

TABLE 3

Rf values of known sugars and the sugars present in Bartlett pears

Sugar	R values [1]	
	Known	Unknown
Fructose	.53	.53
Glucose	.48	.48
Sucrose	.38	.38
Maltose	.29	—
Lactose	.24	—

[1] Solvent: propanol-ethanol-water, 7:1:2 (v/v).

the alcohol extract was concentrated tenfold. The occurrence of a small concentration of sucrose in these canned samples was not in agreement with results of analyses conducted by Strachan *et al. (29)*, who found that sucrose was 16% of the total sugar in Bartlett pears. Because of this, a fresh Bartlett pear sample at an average pressure test of 2.1 pounds was lyophilized and extracted with alcohol in the same manner as pears canned in distilled water. Paper chromatography of the alcohol extract indicated the presence of a larger quantity of sucrose in fresh pears than in the canned samples. Thus it appears that sucrose might have been partially hydrolyzed during the canning process. No consistent trends in the quantity of the sugars among the various samples could be detected by the intensity or size of spots on the chromatogram.

Quantitative analysis of sugars. The results of the quantitative analysis of reducing and non-reducing sugars and the soluble solids of the 1953 canned samples are presented in Figure 3. They are the average of determinations from both slurry and lyophilized pulp. Refractometer readings of the canned samples showed that soluble solids had increased during maturation on the tree and during storage at 32° F. (0° C.). Soluble solids then increased slowly but steadily during ripening at 68° F. (20° C.), until the fruit tested 2.4 pounds; further ripening caused a sharp increase until the fruit tested 1.5 pounds. Below that point, little change in soluble solids was apparent. The increase in reducing values expressed as dextrose equivalents (DE) followed the same pattern as that for soluble solids. However, rapid decrease in DE in the samples canned at pressure tests below 1.5 pounds was noted.

Pectin change accompanying ripening. The changes in pectin content of pears canned at different pressure tests are shown in Table 4. Pectin breakdown in Bartlett pears during ripening was gradual. During ripening, as measured by pressure test of the fresh fruit, water-soluble pectin increased gradually, indicating the conversion of protopectin to soluble pectin. When the pressure test of the fresh pears dropped below 1.9 pounds, almost all of the protopectins had been converted into soluble pectins. Total pectin content also decreased with maturation. This might be attributed to hydrolysis of the water-soluble pectin to oligogalacturonides or galacturonic acid no longer precipitable by alcohol. The occurrence of galacturonic acid in ripe pears, as reported by Ash and Reynolds *(2)*, seemed to support this hypothesis. The decrease in total pectin might also be caused by utilization of galacturonic acid by the pear tissue as a source of energy. This point needs further investigation.

Characteristics of versene-extracted pectic materials from canned pears. The characteristics of versene-extracted pectic materials derived from Bartlett pears canned at different pressure tests are shown in Table 5. It is apparent that the neutral equivalent and intrinsic viscosity of the pectic materials decreased with a decrease in pressure test. The decrease in neutral equivalent was caused by de-esterification of the pectic materials

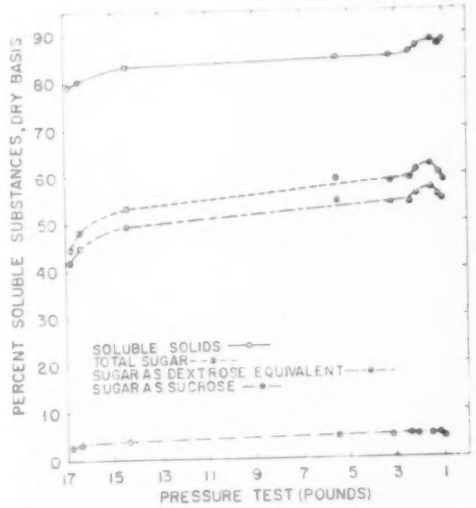

Figure 3. Changes in soluble substances and sugars in Bartlett pears canned at different pressure tests (1953 water pack).

by the enzyme pectin-esterase *(33)*, forming more carboxyl groups in the galacturonide chain. Intrinsic viscosity is a property representing the molecular size or length of the polygalacturonide chain of the extracted pectin. The decrease in intrinsic viscosity of the extracted pectin indicates the hydrolysis of the pectin molecules by the enzyme polygalacturonase *(34)* to smaller units. It can be seen that the pectins extracted from samples canned at pressure tests of 3.2 and 2.4 pounds had nearly equal intrinsic viscosities. The sample canned at 1.0 pound pressure test had an intrinsic viscosity of only 1.60 Dl. per g. McCready and McComb *(23)* reported an intrinsic viscosity value of 6.0 for versene-extracted pectin from unripe Bartlett pears, but 1.5 from ripe fruit. Their results agree with data obtained in this investigation.

TABLE 4

Increase of soluble pectin accompanying maturation of Bartlett pears

Average pressure test of fresh pears in lbs.	Pectin content in canned pears on dry basis		Water-soluble pectin in total uronides %
	Water-soluble pectin %	Total pectin %	
3.8	1.56	2.44	63.9
3.2	1.43	1.81	79.0
2.4	1.70	1.94	87.6
1.9	1.88	1.89	99.5
1.0	1.28	1.29	99.4

From the above results, it seems likely that complete hydrolysis of a portion or all of the pectin molecule to oligouronides and galacturonic acid has occurred when pears ripen to low pressure test. The finding of Ash and Reynolds *(2)* that free galacturonic acid is present in ripe, but not green, pears seems to support this hypothesis.

DISCUSSION

A comparison between changes in acids (Figures 1 and 2) and in reducing substances as dextrose equiva-

lents (Figure 3) in samples canned at pressure tests below 5.5 pounds indicates a very interesting relationship. As the pressure test dropped from 5.5 to 1.5 pounds, a rapid decrease in malic and citric acids was accompanied by a rapid increase in reducing substances. Other researchers *(9, 10, 30)* have reported an increase in sugars but little change in acid during ripening of Bartlett pears. However, their results were based upon non-specific procedures for these constituents—reducing value methods for sugars and total acid determination for acidity.

It is generally assumed that the increase in reducing value during ripening results partially from hydrolysis of starch to maltose or glucose. However, since paper chromatography failed to detect any maltose in pears or quantitative changes in sugars during ripening, it seems unlikely that the increase in reducing value came entirely from the hydrolysis of starch.

TABLE 5

Properties of versene-extracted pectic materials isolated from canned Bartlett pears

Average pressure test of fresh pears in lbs.	Neutral equivalent	Intrinsic viscosity
16.4	1163	5.65
5.5	1015	4.80
3.8	1007	3.90
3.2	870	3.20
2.4	885	3.40
1.0	675	1.60

It is also possible that the increase in reducing value, particularly during the late stages of ripening, could be due to hydrolysis of pectin to low molecular weight oligouronides by the enzyme polygalacturonase. The presence of polygalacturonase in ripe Bartlett pears has been demonstrated by McCready and McComb *(23)* and Weurman *(34)*. This enzyme causes hydrolysis of alpha-1,4,-linkages in the polygalacturonide chain of the pectin molecule to liberate the aldehyde group on carbon number 1. Simultaneous action of pectinesterase and polygalacturonase may partially account for the increase in both titratable acidity and reducing value during the latter stage of ripening.

Assuming there is little change in acid content during processing, results of this investigation might be correlated in general with respiratory activity of pears. The respiratory rate of pears during ripening increases to a maximum and then declines. Ulrich and Paulin *(31)* showed that maximum respiratory activity coincided with best eating quality of pears. Indications are that decreases in malic and citric acids are associated with the climacteric rise, and that a possible increase in both acids in the later stages accompanies senescence. The apparent decrease in malic and citric acids and the presence of the various intermediates of the tricarboxylic acid cycle indicate operation of the Krebs cycle during ripening of pears. It is difficult to explain why respiratory activity decreases and senescence begins when considerable respirable material is still present. Possibly the structural breakdown of the fruit and the increase of volatile reducing substances *(21)*, such as methanol, acetaldehyde, and acetyl methyl carbinol, during ripening might inhibit some phase of the respiratory enzyme system, causing a piling up of malic and citric again at senescence.

The work of Leonard *et al. (19)* and Luh *et al. (21)* indicated that pears canned at average pressure test of 1.5 pounds score higher in flavor than those canned at lower or higher pressures but graded lower in texture. At this pressure test malic and citric acids were at their lowest, while soluble solids were at their highest. All these constituents are important in determining the acceptance of the canned product. It is important to point out that in this project pears with an average pressure test of 2 pounds were found to be best suited for canning to insure good texture as well as flavor in the canned product.

SUMMARY

Bartlett pears were ripened to different pressure tests and canned. The canned products were analyzed for malic and citric acids by silica-gel column chromatography and paper chromatography. Results indicate malic and citric acids are the major acids. When the pears were ripened at 68° F. (20° C.) to pressure test below 5.5 pounds, malic acid decreased rapidly, citric more slowly. Both acids appeared to reach a minimum value when the pressure test was 1.5 pounds. Further ripening seemed to be accompanied by an increase in the two acids. A possible relation of organic acid metabolism to respiration and senescence is suggested.

Chlorogenic, alpha-ketoglutaric, glycolic, pyruvic, and possibly succinic and lactic acids were present in canned Bartlett pears in minute concentrations. Glucose, fructose, and sucrose were the only sugars found by paper chromatographic methods.

Increases in soluble solids and reducing value accompanied ripening. This was thought to be caused partly by the conversion of protopectin to soluble pectin and the hydrolysis of the water-soluble pectin to low molecular weight uronides. The intrinsic viscosity and neutral equivalent of versene-extracted pectin in pears decrease with the decrease in pressure test, indicating glycosidic hydrolysis of the polygalacturonide chain and de-esterification of the methyl ester groups in the pectin molecule during ripening.

The importance of organic acids, sugars, and pectin in quality of canned Bartlett pears is discussed.

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Effect of Freezing Conditions on Appearance of Frozen Turkeys[a]

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Packaged, ready-to-cook, 140° F.-scalded, Broad Breasted Bronze tom turkeys of two ages (13 to 14 weeks and 6 months) were frozen in a blast tunnel under experimental conditions varying with respect to prechilling, blast-air temperature and velocity, and presence of insulative boxing. Measurements were made of rates of temperature change in the skin, under the skin, and in the flesh. Corresponding observations were made of the frozen appearance.

For equivalent degrees of finish (amount of fat in skin layer) faster rates of freezing yielded lighter frozen appearance. On a comparative basis within the commercial ranges studied, optimum appearance was most critically affected by the degree of finish and by freezing in a box versus the open-air blast. Moderate effects were obtained by variation of air temperature and air velocity in the commercial range. Close attention to these factors is essential for production of optimum frozen appearance in poultry processed by current practices. No appreciable differences in frozen appearance were observed between ice-chilled turkeys and those frozen immediately from the warm eviscerated state.

From the viewpoint of the consumer, the appearance of frozen ready-to-cook poultry is of primary importance, because it is the only quality factor that can be judged before purchase. It is then the natural concern of the processor to develop and maintain an optimum, light, pleasing appearance in the packaged product. Recent trends in production and processing of poultry, and particularly turkeys, have altered the inherent appearance of freshly dressed birds and have imposed stricter requirements for freezing in order to obtain acceptable and optimum frozen appearance. In production there has been a trend toward the marketing of immature (fryer-roaster) turkeys with thin, darker-appearing skin due to lack of subcutaneous and intracutaneous fat. A possibly more significant trend is the increased use of higher (140° F.) scalding temperatures which, although producing a feather-free bird at reduced cost, results in the removal of the outer skin layer and exposure of a darker surface much more susceptible to darkening and dehydration. These developments have created a need for all possible modifications in processing and freezing that will produce lighter appearance of the frozen surface. It was therefore considered desirable to re-evaluate the freezing requirements for turkeys, with particular attention to appearance of high-temperature-scalded and immature birds.

Factors that were studied included air blast temperature, air blast velocity, degree of finish (amount of fat in skin layer), freezing box-packed turkeys compared with freezing turkeys on open shelves in the blast tunnel, and freezing ice-chilled eviscerated turkeys compared with freezing warm freshly eviscerated turkeys. Rates of freezing were recorded under the various experimental conditions and correlated with the final frozen appearance. The results emphasize the beneficial effect on frozen appearance of good finish and freezing on open shelves in a blast tunnel, and also indicate the extent of improvement to be derived from lower air blast temperature and higher air velocity.

EXPERIMENTAL

General procedures. Broad Breasted Bronze turkeys were shocked to reduce struggling, bled by an outside neck cut, scalded at 140° F. for 30 seconds, picked by machine, and immediately eviscerated. During evisceration, and in the short delay before packaging or ice chilling, the surface of the turkeys was kept moist by frequent spraying with tap water. Chilling was carried out by submerging the eviscerated carcasses in mixtures of water and cube ice for about 4 hours, which in general reduced the temperature in the breast to a range of 40° to 45° F. Turkeys were packaged in evacuated, heat-shrunk, plastic bags. In general, freezing was carried out in an experimental air-blast tunnel freezer which could accommodate standard-size wire-bound wooden turkey boxes in a lower segment and individual turkeys in the open air of the blast in the upper segment. Temperature of the air blast could be accurately controlled and recorded. The velocity could be set for either 600 or 1300 feet per minute and actual velocities varied. Continuous records of temperature in the freezing carcass were obtained at three locations: (a) under packaging film and on top of skin in breast region, (b) under breast skin and on top of flesh, and (c) in flesh of breast to depth of one inch. Frozen appearance of the packaged and unpackaged turkeys was noted, and pictures in black and white and in color were taken to record as far as possible the observed differences between experimental treatments. Satisfactory reproducibility of appearance and temperature changes between replicate turkeys at each of the specified freezing conditions was established for 6-month turkeys with the use of 4 turkeys per condition. In subsequent studies with 14-week turkeys, the number of replications for each of the 12 freezing conditions was reduced to two. Agreement between duplicates was excellent. Observations on changes in isolated skin and flesh were confirmed in 3 separate tests, one with turkeys and two with chickens.

Preliminary observations on behavior of skin layer. It is well known that 140° F. scalding leads to removal of the epidermal layer in the usual operation, resulting in a surface of altered appearance and greater susceptibility to dehydration and darkening. To a considerable extent the darkening can be attributed to a greater transparency of the surface layer, which permits light to penetrate and be partially absorbed. In the overall freezing operation, the skin may be cooled to the freezing point so slowly that it has ample time to dry in the thawed state, shrink, become more transparent, and hence acquire a darker appearance. More important, the skin may be cooled through the freezing range so slowly that large ice crystals are formed in preference to small ones. The larger the ice crystals, the

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more transparent the surface layer, and consequently the darker is the appearance of the overall surface. A theory of the relation between rate of freezing of meat and its frozen appearance was developed as early as 1932 by Moran *(4)* in terms of the size of ice crystals formed, and this effect was investigated in poultry by Koonz and Ramsbottom *(3)* in 1939. Moran's criterion for adequate freezing rate was that the temperature of the tissue should fall from 41° F. to 23° F. within 30 minutes in order to obtain the typically light appearance associated with small-sized ice crystals.

Several preliminary freezing experiments with turkeys were run in an attempt to estimate the maximum depth beneath the surface for which the above criterion has any significance with respect to surface appearance. Observations were made of the skin of fast- and slow-frozen turkeys, as the skin appeared on the intact bird, and as it appeared when removed from the bird and placed on a white background. Also, as far as it was possible in working with the frozen tissue, the frozen appearance of the exposed underneath flesh surface was noted for birds frozen fast and slow. Similar experiments were carried out with 9-months-old, meat-type chicken cockerels. Strips of blackened aluminum foil and white paper were inserted between skin and flesh, in order to differentiate between optical changes in the skin and in the flesh surface that occur during freezing. Also, in some cases, the skin was stripped from the bird and stretched about a pseudo-carcass possessing latent heat content, specific heat, and conductivity similar to those of the actual carcass, in order to reproduce the actual rates of temperature change in the skin during fast and slow freezing. Skinned birds, the skin-covered pseudo-carcasses, and the intact birds with foil under the skin were packaged in heat-shrunk plastic film to prevent moisture loss, and were frozen at rapid (−30° F. air blast, 1300 F/M) and slow (+10° F., still air) rates. Comparison of the effects in skin and flesh are shown in Figures 1, 2, and 3.

Figure 1. Effect of freezing rate on frozen appearance of packaged ready-to-cook cockerels. A broad strip of blackened aluminum foil surmounted by a narrow strip of white paper was inserted between flesh and skin in order to determine the changes in the skin apart from the flesh. No. 254, frozen rapidly at −30° F., 1300 ft. per min., illustrates the relative opaqueness produced by small ice crystals, while No. 255, frozen slowly at +10° F. in still air, illustrates the relative transparency of the slow-frozen skin and hence its significant role in the overall surface darkening.

Tests with both turkeys and chickens support the following conclusions. Of the overall surface lightening produced by fast freezing, a considerable part takes place in the skin, which during fast freezing becomes less transparent; the remaining and equally important portion of the change occurs in a very thin surface layer of the flesh. Positions appreciably below the surface of the flesh are of no practical importance in establishing frozen appearance of the bird. This suggests, as a practical criterion by which to evaluate freezing rates for chilled poultry, the time required for the temperature just under the skin to reach 20° F. At this temperature practically all of the water

Figure 2. Effect of freezing rate on frozen appearance of flesh surface of packaged, skinned cockerels. A slanting wedge-shaped cut was made in each side of the breast, and strips of blackened aluminum foil inserted in order to demonstrate the relatively slight depth to which light penetrates the flesh. The slow-frozen flesh (No. 256 F.) was, of course, more transparent and darker than the fast-frozen (No. 257 F.).

in the tissue is frozen. For comparative purposes we shall indicate such times for the freezing rate curves to follow.

Effect of finish and size on freezing rate and frozen appearance. In order to simplify examination of the freezing-rate data, differences in temperature between the three thermocouple locations in the carcass (under packaging film and on skin, under skin and on flesh, in flesh to depth of one inch) are

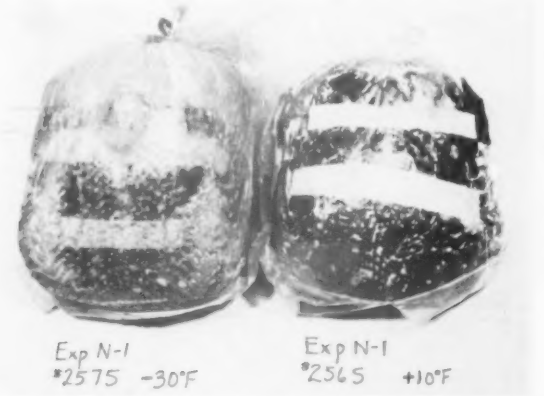

Figure 3. Effect of freezing rate on transparency of isolated skin from cockerels. Skins were stretched over pseudo-carcasses, consisting of plastic film bags filled with gelatin solution and covered with strips of blackened aluminum foil and paper to facilitate comparisons of relative transparency. Resulting "carcasses" were packaged in heat-shrunk film and frozen at −30° F., 1300 ft. per min. versus +10° F., still air. The much greater transparency of the slow-frozen skin (No. 256 S) is quite evident.

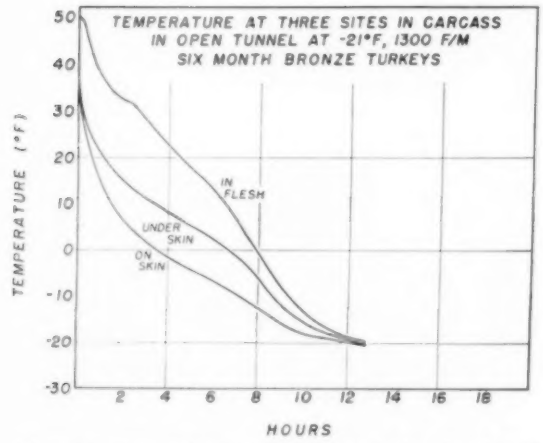

Figure 4. Temperatures at 3 locations during freezing of packaged, ready-to-cook Bronze tom turkeys of 21 lbs. weight. Thermocouples were inserted under packaging film and on skin, under skin and on top of flesh, and at a 1-inch depth in the flesh, all three being in the breast region.

presented in Figures 4 and 5, after which data will be given only for the most critical site, just under the skin. Figure 4 shows the temperature gradients developed during the freezing of a well-finished turkey, where the surprisingly large spread in temperature between outer and inner surface of the relatively thin (1 to 2 mm.) skin is a reflection of the pronounced insulating property of this fatty layer. In contrast, Figure 5, containing essentially the same data for a poorly finished immature turkey with a much thinner, relatively fat-free skin, indicates practically no temperature gradient in the skin layer. When this effect of poor finish is added to the effect of smaller size of the immature fryer-roaster turkey compared to the heavy mature turkey, we arrive at a great difference in freezing rates of the superficial layers for the two sizes of turkeys, as illustrated by the data plotted in Figure 6. These two factors (less insulation in skin and smaller size) which both lead to more rapid freezing are the only two factors working in favor of a smaller bird as far as frozen appearance is concerned, and they obviously fall far short of overcoming the inherently darker appearance of the poorly finished immature bird.

Freezing in boxes versus freezing in open air of tunnel. An insulating effect during freezing of far greater potential magnitude than that of the skin is the insulation introduced by the packaging or boxing present. This insulation is derived from the boxing material and the blanket of still air that it encloses. To obtain a measure of this effect, comparably packaged turkeys were frozen simultaneously in the same blast tunnel, some in the open air of the blast and some packed in a wire-bound wooden box. The box was surrounded on 4 sides (above, below, upstream, downstream) by empty boxes with spacers, to simulate a heavily loaded freezing tunnel.

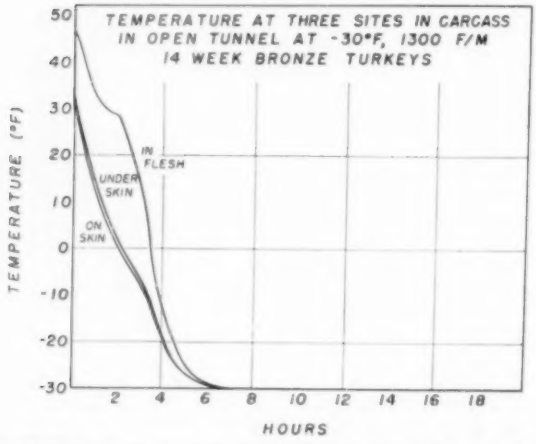

Figure 5. Temperatures at 3 locations described under Figure 4, during freezing of packaged, ready-to-cook Bronze tom turkeys of 7 lbs. weight.

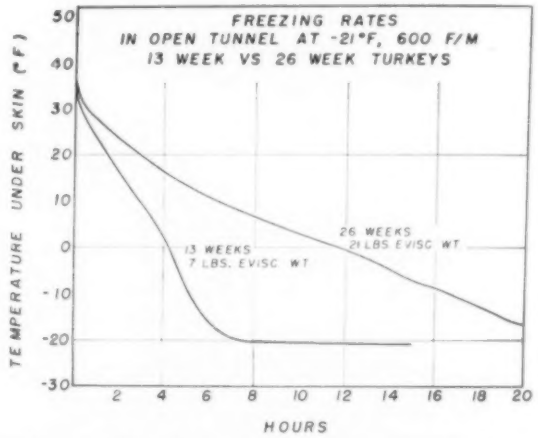

Figure 6. Effect of size on rate of temperature change under skin of packaged, ready-to-cook Bronze tom turkeys.

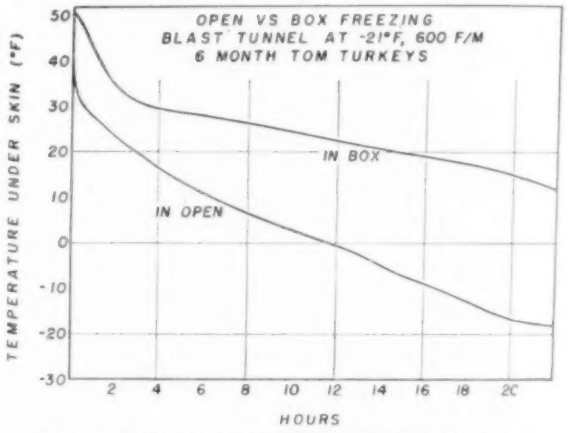

Figure 7. Rates of temperature change under skin for open versus box freezing of packaged, ready-to-cook, 21-lb. Bronze tom turkeys.

For 6-months-old turkeys (Figure 7) the time required for the temperature under the skin to reach 20° F. was 3 hours in the open tunnel compared to 15 hours in a box. Corresponding times for 14-week turkeys (Figure 8) for open and box freezing were 1½ and 6½ hours, respectively. These large differences due to insulative effect of the box were reflected as expected in marked differences in frozen appearance, as shown for 14-week turkeys in Figure 9.

Differences in times for the interior of the birds to reach frozen storage temperature (0° F.) were also large for the two freezing conditions. For example, time for flesh at a 1-inch depth of 6-month turkeys to reach 0° F. was 14 hours for open freezing compared to 27 hours for box freezing.

Effect of temperature and velocity of air blast on freezing rate and frozen appearance. Turkeys were frozen under all

combinations of 3 air temperatures (values of —10, —20, and —30° F.) and 2 air velocities (600 and 1300 feet per minute). Recorded air temperatures did not differ in any case from these values by more than 2 degrees. Air velocities varied with location in the blast tunnel and, by tests in the open section with a 4-inch pinwheel anemometer averaged 551 F/M for the 600 F/M setting, and 1080 F/M for the 1300 F/M setting.

From Figure 10, which traces the rate of temperature change of turkeys in an open 600 F/M blast for the 3 air temperatures

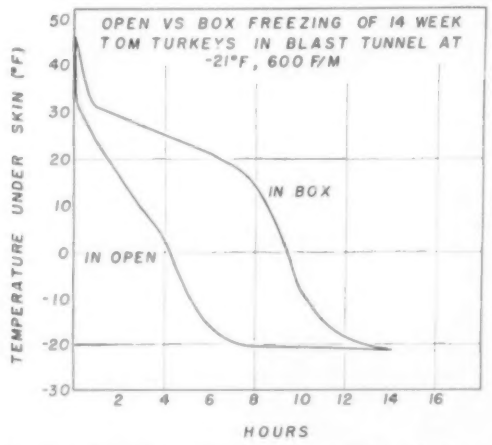

Figure 8. Rates of temperature change under skin for open versus box freezing of packaged, ready-to-cook, 7-lb. Bronze tom turkeys.

Figure 9. Effect of open versus box freezing on frozen appearance of packaged, ready-to-cook 7-lb. Bronze tom turkeys. Birds were scalded at 140° F., chilled in ice slush to about 40° F., packaged, and frozen in air blast at —30° F., 1300 F/M. Nos. 54-143 and 54-145 were frozen in open; Nos. 54-144 and 54-146 were frozen in box.

studied, it is apparent that the beneficial effect of reducing air temperature in the —10° to —30° F. range is much less than that obtained by substituting open freezing for box freezing. In the open tunnel with a 600 F/M blast, times for the under-skin temperature of 14-week tom turkeys to reach 20° F. were 2½, 1½ hours, and 1 hour, respectively, for air temperatures of —12° F., —21° F., and —31° F. Corresponding differences in frozen appearance between turkeys frozen at the 3 air temperatures, as shown in Figure 11, are detectable but only of practical significance in the case of the —12° to —21° F. comparison or the —12° to —31° F. comparison.

Freezing rates at the higher air velocity, 1300 F/M, were significantly greater at all 3 temperatures, with the differences in freezing rate and appearance between temperatures less marked at the higher air velocity. As expected, improvements

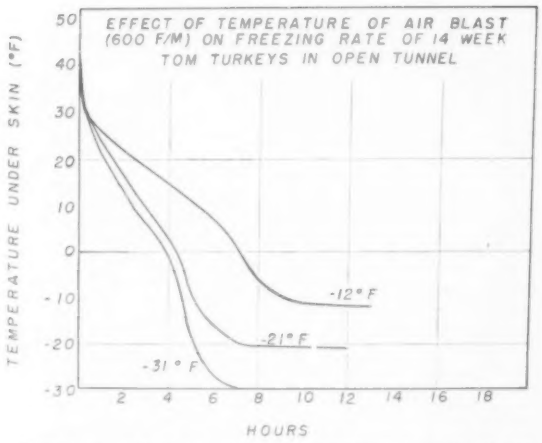

Figure 10. Effect of air-blast temperature on rate of temperature change under skin of packaged, ready-to-cook, 7-lb. Bronze tom turkeys.

due to higher air velocity were more noticeable at the higher air temperatures, with appreciable effects only at —12° F. Figure 12 indicates that the time for under-skin temperature of 14-week tom turkeys to fall to 20° F. decreased from 1½ hours to about 20 minutes, due to an increase in air velocity from 600 F/M to 1300 F/M. The corresponding improvement in frozen appearance was slight.

Relative freezing rates of warm and ice-chilled turkeys. Some processors have eliminated a separate chilling operation by packaging the warm carcass immediately after dressing and evisceration, and placing it at once in the freezing tunnel. It was therefore of interest to compare the rates of temperature change in two cases, one as described above and one in which the warm eviscerated carcasses were chilled in ice and water for 4 hours before packaging and freezing. Figure 13 contains the resulting freezing curves for 6-month turkeys. The flesh temperature of the non-chilled carcass lagged 3 to 5 hours behind that of the chilled carcass, so that the overall cooling period from the warm eviscerated state to any specified temperature was about the same in the two cases. The corresponding lag for the under-skin temperature in the freezing range was much less. Times in the blast tunnel for under-skin temperature to fall to 20° F. were 1 hour for the ice-chilled carcass compared to 2½ hours for the non-chilled carcass. Differences in frozen appearance for the two procedures were not appreciable nor of practical importance.

Figure 11. Effect of air-blast temperature on frozen appearance of packaged, ready-to-cook, 7-lb. Bronze tom turkeys, at air-blast velocity of 600 F/M. Blast temperatures were for 54-123, —31° F., 54-119, —21° F., and 54-131, —12° F.

For immature (13 weeks) turkeys, the differences in freezing rates between ice-chilled and warm carcasses were much less than those for 6-month turkeys. Times for under-skin temperature to reach 20° F. from the ice-chilled and warm states were 70 and 85 minutes, respectively. Similarly to the older birds, the warm and ice-chilled 13-week birds developed essentially the same appearance in the frozen state.

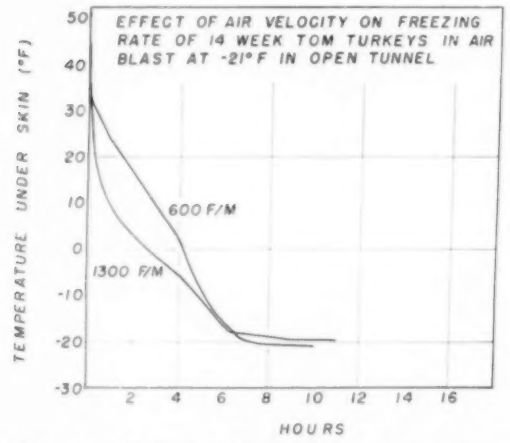

Figure 12. Effect of air-blast velocity on rate of temperature change under skin of packaged, ready-to-cook, 7-lb. Bronze tom turkeys.

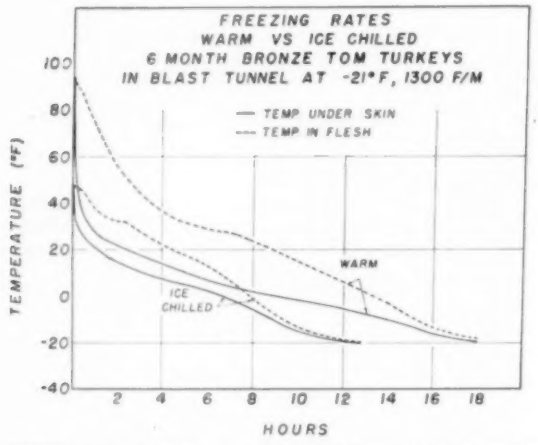

Figure 13. Freezing rates for warm versus ice-slush-chilled packaged, ready-to-cook, 21-lb. Bronze tom turkeys.

DISCUSSION

Our results which point to the beneficial effect on appearance of rapid freezing are in general agreement with those of Baker *(1, 2)*, who demonstrated and emphasized the need for rapid freezing of poultry. However, there are several cases in which either the results, interpretations, or conclusions differ significantly, and these will be discussed in the interest of clarification.

Baker *(1)* froze isolated pieces of chicken broiler skin on wooden boards at 2 widely different air temperatures (—20° F. air blast versus +20° F. still air) and also froze the skinned carcasses at the 2 air temperatures. Finding that the appearance of the frozen flesh surface was much lighter for the —20° F. air-blast freezing, but that there was no difference in appearance of isolated skin due to freezing air temperature, Baker concluded that the discoloration occurred in the flesh and not in the skin. In contrast, our comparative studies described in this report, in which the skin was maintained as nearly as possible under the same conditions of contact with a heat reservoir as exist in the intact birds, demonstrate that appreciable and easily detectable optical changes take place in the skin in addition to those in the flesh surface layer. A possible explanation for the lack of difference in appearance of isolated skins frozen by Baker is that the rate of temperature change in the isolated skin in +20° F. still air was much more rapid than it would have been if the skin had been in natural contact with the flesh, and hence never approached a low enough rate of change to permit large ice crystal formation and consequent darkening. Baker has also reported that water chilling resulted in a darker frozen appearance than air chilling. Our tests on the effect of holding unpackaged 140° F.-scalded carcasses in a commercial 38° F. circulating-air-chilling room have indicated that such air chilling results in a darker frozen appearance than a typical 4-hour ice-slush chilling. It should be pointed out, however, that Baker's conditions of air chilling, with wet cheesecloth wrapped about the bird to prevent dehydration, are not typical of commercial air chilling, which may in part explain the conflicting results. On the basis of our observations and in consideration of possible bacteriological hazards, we do not agree with the statement in Baker's report that it might be wise to thaw discolored carcasses through the skin before selling. Although the thawed appearance is distinctly different from the slow-frozen appearance, we have not considered it to be superior or more appealing.

Acknowledgment

We are indebted to the Refrigeration Research Foundation who provided much of the experimental material for these studies.

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Changes in Pectic Substances of Tomatoes during Storage[a]

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Changes in pectic substances of tomatoes harvested at the red-ripe stage were studied during a storage period of 21 days. Protopectin decreased and pectin increased. A relationship between the changes in pectic substances and the time interval of harvest was noted.

Softening of fresh foods is an early indication of deterioration. In order to develop methods for inhibiting the reactions that produce softening, it is necessary that the chemical changes involved be ascertained. Since pectic substances are postulated to be tissue firming agents, a study of the changes in pectic substances of tomatoes during storage was undertaken. These data, it was believed, could be used to help explain the softening process and ultimately be used in the development of methods for the retardation of deterioration in fresh foods.

Pectic substances have been defined and classified by a committee under the guidance of Kertesz *(6)*. Investigations by Kertesz *(3)* indicated that pectic materials contribute greatly to both the consistency and thickness of tomato juice and tomato catsup. A decrease in pectic constituents contributed to liquefaction and subsequent deterioration. During storage, pectic substances in these products were hydrolyzed, unless pectic enzymes were inactivated by proper treatment.

The pectic components of tomatoes, Jacobs *(2)* suggested, form a firm gel around the fibrous tissue of the fruits, their function being to prevent the collapse of the fruit and to aid in keeping it firm. As the pectic components of tomatoes are converted to less complex units, there is a decrease in firmness and ultimate collapse of the fruit.

A complete discussion of the pectinase complex was presented by Phaff and Joslyn *(8)*. Pectase, or pectin esterase, catalyzes the hydrolytic removal of methyl alcohol from the pectin molecule. The enzyme is found in leaves, roots, and fruit. Tomatoes are one of the principal sources of pectase. Polygalacturonase is formed principally by microorganisms, but it is found in small quantity in higher plants. This enzyme catalyzes the hydrolysis of the 1-4 glycosidic bonds between two galacturonic acid residues in a pectic acid chain. Before polygalacturonase can act, the pectin must be almost completely deesterified. Pectase deesterified pectins are acted upon by polygalacturonase before acid or alkali deesterified pectins.

The exact way in which pectic substances are degraded is not completely known. One postulation is that the insoluble protopectin is hydrolyzed to soluble pectin, which is turn may be demethylated and hydrolyzed to smaller acid residues. Some evidence has been presented to confirm this postulation.

Kertesz *(4)* developed a method that measures small amounts of galacturonic acid in apple tissue. If galacturonic acid accumulates during ripening and softening of apples, this would indicate that pectin may be decomposed to its component parts. The determination of galacturonic acid is a new approach to the study of the relationship of pectic substances to storage life of fresh foods.

The investigation reported below is concerned with the pectic substances of tomatoes during storage.

PROCEDURE

Queen's variety of tomatoes were the test material. Preharvest treatment consisted of copper sprays for blight and lead arsenate sprays for insect control. When the fruits began to ripen, the plants were spread out so that the maximum sunlight could reach the fruits. The tomatoes were harvested at the red-ripe stage, and they were selected on the basis of color and freedom from cracks and "nail-head" disease, which was prevalent.

The tomatoes were washed, air dried, and divided into four approximately one-kilogram samples, which were weighed prior to storage at 40° F. Storage was in a natural convection refrigerator. Samples were removed for analysis on 0 and after 7, 14, and 21 days of storage. The samples were reweighed to determine weight loss, which was approximately 10 g. per week.

Extraction and precipitation of pectic substances. The methods used for the extraction and precipitation of pectic substances were those outlined by Kertesz *(5)*.

Approximately one kilogram of tomatoes, weighed to within 0.1 g., were skinned and cut into a measured volume of 95% ethanol, so that the final mixture contained 70% by volume of alcohol. The mixture was simmered for 5 minutes, cooled overnight, and further dehydrated with alcohol and ether. The residues were dried at 60° C. until no odor of ether was discernible and stored in bottles under refrigeration for subsequent analysis.

The entire quantity of alcohol insoluble solids was used in preparing the various pectin fractions. The alcohol insoluble solids were extracted twice with water to extract pectin, the residue then extracted with 0.5% ammonium oxalate solution to extract pectate, and finally the residue was extracted twice with 0.05M hydrochloric acid to extract protopectin.

The extracts were separately precipitated with two volumes of 95% ethanol, the normality of the mixtures adjusted to 0.05 with hydrochloric acid and the precipitates collected on sharkskin filter paper by using suction. After washing, the precipitates were removed from the filter paper and fried at 85° C. The quantity of pectic substances present in tomatoes was expressed as milligrams per kilogram of the original wet weight of the skinned tomatoes.

The relative viscosity of the precipitates was determined by using the method of Hinton *(1)*. The viscosity of the solutions was determined in an Ostwald viscometer at 30° C. by using water as the standard liquid. The relative viscosity of the pectin solutions was calculated by using the following formula:

[a] Paper of the Journal Series, New Jersey Agricultural Experiment Station, Rutgers University, the State University of New Jersey, Department of Food Technology, New Brunswick.

$\frac{n}{1} = \frac{d_1 t_1}{d_w t_w}$, where "d" is the density, "t" is the time in seconds, and "n" is the coefficient of viscosity.

Duplicate portions of the above solutions were used to determine the purity of the alcohol precipitates by the calcium pectate method of Poore *(9)*. The calcium pectate content of the alcohol precipitates was expressed as a percentage and was an average of two determinations.

The methoxyl content of the alcohol precipitates was determined according to the method of Hinton *(1)*, with some modifications. Duplicate 0.1 g. samples were dissolved in 40 ml. of hot water, cooled, and the solution adjusted with 0.1 N sodium hydroxide to a pH of 7.5 by using a Beckman pH meter. To each flask were then added 10 ml. of 0.5 N sodium hydroxide, and the flask was allowed to stand for 30 minutes at room temperature.

The excess alkali was then titrated with 0.1 N hydrochloric acid to a pH of 7.5 by using a glass electrode. The difference between the blank and this back titration gave the amount of alkali used for the saponification which is expressed in grams of sodium hydroxide per 100 g. of alcohol precipitate. The methyl alcohol content of the precipitates was calculated by multiplying the milliequivalents of sodium hydroxide times 0.8, the milliequivalent of methyl alcohol. The methyl alcohol content of the precipitates was expressed as percent methoxyl.

RESULTS

The results of the determination of alcohol insoluble pectic fractions on Queen's variety of tomatoes are presented in Tables 1 through 6. Table 1 shows the quantity of the water soluble fraction pectin, found in the tomatoes during storage at 40° F.

TABLE 1

The pectin content of tomatoes during storage (water soluble fraction)

(Expressed as milligrams per kilogram of tomatoes)

Lot	0 days	7 days	14 days	21 days
1	247.8	1116.0	592.8	570.9[1]
2	288.6	328.0	126.2	342.2
3	401.0	823.0	278.9	736.3
4	782.2	640.9	1536.0	623.2
5	235.8	522.9	393.9	282.6
6	313.8	534.9	549.9	669.4
7	431.9	345.9	668.3	693.0
8	350.3	590.0	640.1	619.5
9	356.0	676.4	619.5	601.7
Mean lots 1-9	378.6	608.6	601.7	570.9
Mean lots 5-9	337.6	533.9	574.3	573.2

[1] Calculated value for statistical analysis:
"F" for lots 1-9 = 1.55—not significant
Least significant difference between means lots 5-9:163.7
"F" for lots 5-9 = 4.28—significant
Least significant difference between means for lots 5-9:163.7
Coefficient of correlation for lots 5-9:+0.570

for 21 days. When lots 5 through 9, which were harvested within one week, were grouped as replicates for statistical analysis, using an analysis of variance *(9)*, a significant difference was found between days of storage. The coefficient of correlation of increase in water soluble pectin content with time was + 0.570, which was a highly significant correlation.

Table 2 shows the content of the ammonium oxalate fraction or pectate, of the tomatoes. No significant difference was found between changes in pectate content and increased storage time, either when the 9 lots were treated as replicates or when lots 5-9 were treated as replicates.

TABLE 2

The pectate content of tomatoes during storage (ammonium oxalate fraction)

(Expressed as milligrams per kilogram of tomatoes)

Lot	0 days	7 days	14 days	21 days
1	578.2	725.0	458.0[1]	582.6[1]
2	178.3	772.1	959.6	452.3
3	1163.0	420.3	369.8	1677.0
4	363.1	529.8	322.8	462.4
5	655.2	550.7	364.5	366.9
6	409.8	365.3	511.9	316.5
7	318.9	483.9	288.6	585.3
8	456.5	349.5	428.2	407.2
9	493.9	374.0	418.6	393.3
Mean lots 1-9	512.9	507.8	458.0	582.6
Mean lots 5-9	466.9	424.7	402.4	413.8

[1] Calculated value for statistical analysis:
"F" value for lots 1-9 = 2.62—not significant
Least significant difference between means for lots 1-9:282.7
"F" value for lots 5-9 = 2.54—not significant
Least significant difference between means for lots 5-9:134.7

The acid soluble fraction, protopectin, of tomatoes is shown in Table 3. A significant decrease in protopectin was found with increased storage time. When lots 5 through 9 were grouped as replicates, a highly significant difference was found. The coefficient of correlation of decrease in protopectin content with time was —0.811, which was highly significant.

TABLE 3

The protopectin content of tomatoes during storage (hydrochloric acid soluble fraction)

(Expressed as milligrams per kilogram)

Lot	0 days	7 days	14 days	21 days
1	1694.0	1802.0	1568.0	415.5[1]
2	989.0	1074.0	646.2	845.4
3	917.3	278.8	1820.0	327.6
4	346.1	1375.0	1150.0	279.4
5	1260.0	544.0	983.7	447.8
6	965.6	676.2	395.3	272.1
7	1123.0	818.0	422.3	394.1
8	1106.0	406.8	420.1	356.4
9	1116.0	461.6	409.5	351.2
Mean lots 1-9	1057.4	826.3	868.3	415.5
Mean lots 5-9	1114.0	581.3	526.2	364.3

[1] Calculated value for statistical analysis:
"F" value for lots 1-9 = 3.74—significant
Least significant difference between means for lots 1-9:402.6
"F" value for lots 5-9 = 19.49—highly significant
Least significant difference between means for lots 5-9:220.7
Coefficient of correlation for lots 5-9: —0.811

Table 4 shows the methoxyl content of various fractions.

Table 5 shows the relative viscosities of the pectic fractions. In all cases a decrease in relative viscosity was found as the length of storage of the tomatoes increased.

TABLE 4

The methoxyl content of pectin, pectate, and protopectin during storage

(Expressed as percentages)

Lot	Pectin				Pectate				Protopectin			
	0 days	7 days	14 days	21 days	0 days	7 days	14 days	21 days	0 days	7 days	14 days	21 days
1	15.59	13.53	15.26		10.09	17.86			15.01	14.91	9.88	
2	8.28	11.98	12.82	15.36	11.04	13.71	10.56	13.13	8.52	11.97	10.21	11.78
3	13.04	8.52	12.20	13.45	11.11	10.31	9.93	11.82	10.09	8.21	10.18	10.58
4	11.39	12.38	8.72	10.37	8.39	13.29	12.59	10.62	13.82	10.09	12.14	10.42
5	12.88	12.58	12.82	13.04	11.78	9.47	10.02	9.07	12.62	11.20	10.27	11.84
6	12.68	12.19	11.56	10.60	13.31	11.00	10.88	7.11	11.76	8.00	9.94	7.83
7	9.13	11.54	10.10	9.86	10.20	8.85	8.58	7.45	11.21	8.83	8.11	8.87
8	10.50	11.63	10.80	7.13	13.33	10.41	9.91	7.90	11.51	9.33	8.99	5.54
9	8.47	7.79	9.43	6.66	11.18	7.75	11.21	7.56	6.97	7.64	7.72	7.81

TABLE 5

The relative viscosity[1] of pectin, pectate, and protopectin during storage

Lot	Pectin				Pectate				Protopectin			
	0 days	7 days	14 days	21 days	0 days	7 days	14 days	21 days	0 days	7 days	14 days	21 days
1	1.35	1.30	1.20		1.38	1.20			1.40	1.39	1.29	
2	1.46	1.29	1.25	1.19	1.24	1.24	1.18	1.11	1.51	1.39	1.35	1.35
3	1.41	1.20	1.18	1.18	1.32	1.10	1.16	1.08	1.49	1.26	1.27	1.22
4	1.37	1.37	1.21	1.17	1.20	1.22	1.06	1.05	1.45	1.41	1.27	1.25
5	1.39	1.34	1.34	1.27	1.24	1.18	1.18	1.11	1.48	1.40	1.36	1.34
6	1.38	1.33	1.27	1.23	1.25	1.19	1.17	1.14	1.48	1.39	1.34	1.31
7	1.37	1.27	1.26	1.24	1.26	1.15	1.14	1.13	1.49	1.41	1.35	1.27
8	1.38	1.32	1.31	1.27	1.27	1.21	1.13	1.12	1.50	1.41	1.37	1.37
9	1.38	1.32	1.28	1.27	1.27	1.21	1.17	1.07	1.50	1.42	1.36	1.34

[1] Determinations were made on 1 percent solutions at pH 2.0 and 30° C. on an Ostwald viscometer.

TABLE 6

The calcium pectate content of the three alcohol insoluble fractions

(Expressed as percentages)

Lot	Pectin				Pectate				Protopectin			
	0 days	7 days	14 days	21 days	0 days	7 days	14 days	21 days	0 days	7 days	14 days	21 days
1	91.38	75.82	72.58		81.99	72.65			81.36	69.96	79.59	
2	75.89	79.02	81.25	80.72	83.54	82.75	85.27	82.37	72.67	82.33	96.96	78.90
3	86.51	86.43	90.55	87.29	85.06	90.00	89.05	91.77	89.53	92.02	86.42	86.44
4	83.37	85.33	86.91	92.62	82.19	84.35	92.13	93.41	85.65	85.39	89.28	97.73
5	73.57	85.19	90.70	92.70	88.46	90.92	91.95	90.02	93.11	82.22	92.39	94.24
6	92.70	87.86	87.50	84.03	90.40	90.45	88.39	80.48	91.16	81.77	88.33	86.31
7	88.30	88.24	89.95	82.88	84.29	90.24	89.62	84.46	82.42	86.32	88.88	85.16
8	86.47	86.04	89.59	85.76	88.61	87.02	90.08	89.52	87.89	84.43	93.10	90.13
9	90.37	86.52	91.96	92.13	88.82	90.13	91.56	90.10	91.05	90.15	90.84	90.90

Table 6 shows the calcium pectate content of the three pectic fractions.

Figure 1 shows the average pectin, pectate, protopectin and total pectin content of the tomatoes from lots 5 through 9. Pectin content increased, protopectin decreased, and pectate remained essentially the same during the storage period. The total pectin content, which was the sum of the three fractions, decreased during storage. The greatest decrease in protopectin occurred during the first 7 days of storage, and it was accompanied by the most rapid rate of increase in pectin.

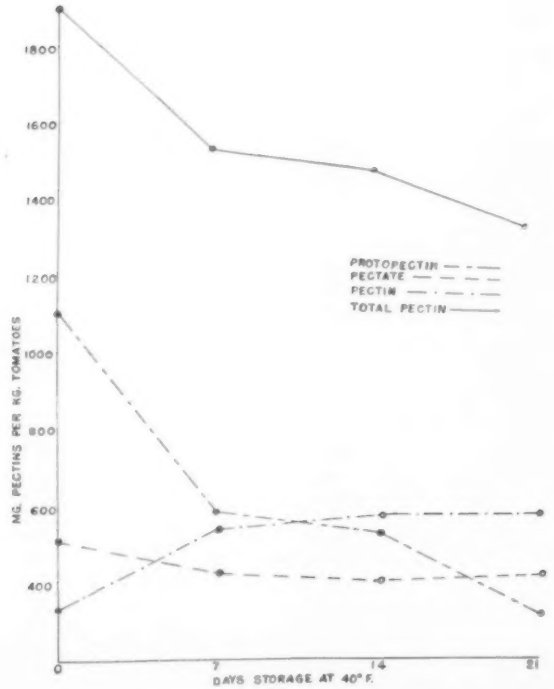

Figure 1. The pectic content of tomatoes during storage. (Mean of lots 5 through 9.)

The application of Snedecor's *(10)* method of least squares to the data from lots 5 through 9 resulted in a calculated curve for pectin and protopectin as shown in Figure 2. There was a marked decrease in protopectin and an increase in pectin in tomatoes during storage. When milligrams of pectin were plotted against milligrams of protopectin, as in Figure 3, a curve with a negative slope of −0.47 resulted.

DISCUSSION

The data indicate that there is a relationship between the changes in pectic substances and the length of storage of tomatoes.

A statistical analysis of the data, when the 9 lots of tomatoes were considered as replicate samples, showed no significant correlation between length of storage and the pectic constituents, except for protopectin. Although there was an increase in pectin, the increase was not great enough to be significant.

The pectate content of tomatoes remained essentially the same. When these data from the 9 lots of tomatoes were treated as replicate samples for statistical analysis, the variation within the individual days of storage was more than twice as great as the variation between the sampling days or days of storage. In other words the variation in pectate content was greater in the replicate samples of any one sampling day than it was between the sampling days.

Protopectin, however, showed a significant decrease during the storage period, when the 9 lots of tomatoes were considered as replicate samples.

The data were regrouped for statistical analysis when an inspection of the data indicated that the time of harvest might have a bearing on the pectic constituents of the fruits. The harvest period extended over a 6-week period; the first 4 lots of tomatoes were harvested during a 5-week period, whereas the last 5 lots were picked

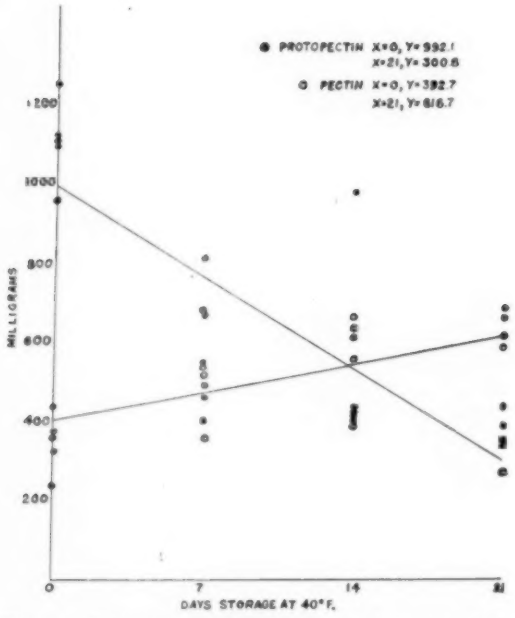

Figure 2. Protopectin and pectin content of tomatoes during storage. (Calculated lines.)

during a single week. Therefore, those lots, which had been obtained during the last week of harvesting, were grouped as replicates in order to ascertain whether or not harvesting during a relatively short period influenced their behavior during storage.

When an analysis of variance was made on the pectin contents of lots 5 through 9, which had been harvested within one week, the increase of pectin was significant

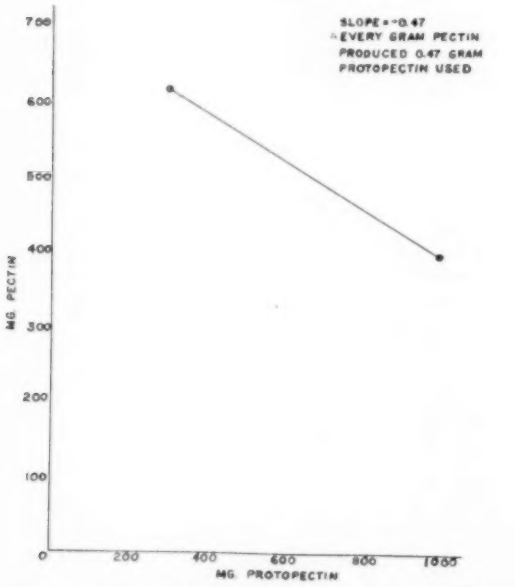

Figure 3. Protopectin-pectin relationship using calculated points at 0 and 21 days storage.

with increased storage time. Since the increase in pectin between sampling days during storage was significant, the coefficient of correlation was determined. The coefficient of correlation was + 0.570, which, according to Snedecor *(10)*, is highly significant for 18 degrees of freedom. The coefficient of correlation meant that in 57% of the cases, the increase in pectin was related to the increase in storage time.

An analysis of variance of the pectate content of lots 5 through 9 showed that there was no significant change in pectate content between days of storage. With pectate, the variation with a single sampling day of storage, as shown by the mean square, was two and a half times greater than the variation between the sampling days.

When the protopectin content of the tomatoes from lots 5 through 9 were considered as replicate samples, a highly significant difference was shown for the decrease in protopectin between the sampling days. The coefficient of correlation was calculated as —0.811, which meant that 81.1% of the changes in protopectin could be related to the length of the storage period.

A definite relationship seemed to exist between the fate of the pectic constituents of tomatoes and the time interval of harvest. Therefore, it is recommended that samples to be used as replicates be harvested within a rather short period.

Relative viscosity, methoxyl content, and calcium pectate content were determined on the various pectic fractions. The relative viscosity of solutions of all pectic substances decreased as the storage period progressed. This indicates that the size of the pectic molecules had decreased. Owens *(7)* showed that the viscosity of pectic substances decreased when the molecules became less highly polymerized.

The changes in methoxyl content of the various pectin fractions were not constant. In most cases the methoxyl content of the fractions decreased with increases in storage time, but in other cases the methoxyl content increased or remained essentially the same. The decreases ranged from 2 to 6%. A decrease in methoxyl content may be an important factor in the changes in pectic constituents of tomatoes during storage.

The calcium pectate content of the three fractions ranged from about 69 to 92%. In most cases it was greater than 80%, which meant that over 80% of the various fractions were pectic substances. The remaining portion was ash or protein which was extracted from the alcohol insoluble solids and precipitated by alcohol. According to Kertesz *(5)* calcium pectate results parallel those obtained by anhydrouronic acid determinations, but the results tend to be higher, unless the calcium pectate values are corrected.

When the pattern of the overall changes in pectic substances are considered, some postulations can be made. Protopectin decreased and pectin increased. The change was accompanied by a decrease in relative viscosity of the pectin, pectate, and protopectin solutions. Some depolymerization had apparently occurred, as was indicated by the decrease in relative viscosity.

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Correction Factors for Heat Penetration Thermocouples

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Studies have been conducted to redetermine the errors in heat penetration measurement caused by conduction of heat along thermocouple wires and by the introduction of heat into the product by thermocouple fittings. The work confirms, in general, previously suggested correction factors. However, a new method of making the correction for the error is suggested in which the correction factor is applied to the lag factor "j."

Minor changes in construction of heat penetration thermocouples have justified a re-determination of the correction factors which compensate for heat conducted into the product by thermocouple wires and fittings. The corrections described below apply to heat penetration data obtained by means of "Ecklund" non-projecting thermocouples when used in small sized cans of conduction heating products.

An earlier report *(3)* suggested the addition of one minute to the slope of the heating curve, f_h, after Ball *(2)*, for cans of conduction heating products $2\frac{11}{16}$ in. diameter and smaller. Recent tests indicate that this correction should be extended to include 300 diameter cans and that the correction for 202 diameter cans should be about 1.7 minutes. However, applying the correction to the "j" value as described below should be more satisfactory.

Correction factors as re-determined. Heat penetration tests were made comparing standard molded non-projecting thermocouples mounted in stainless steel receptacles with special "reference" thermocouples made of very fine wire and inserted in the test cans through externally mounted stuffing boxes (Figure 1).

Analysis of the heating data obtained in each test indicated that lines having identical slopes could be drawn through the semi-log plots of the heating data for the regular and reference thermocouples (Figure 2). Thus, the difference in heating rate was reflected entirely in the lag factor, "j." By multiplying the "j" value obtained with the non-projecting couples by the proper correction factor, the resulting curve could be superimposed on that obtained with the reference couples. The correction factors found for various sized cans of conduction heating products are shown in Table 1. The correction factor for 307 diameter cans is small enough to be disregarded in most cases. The factors for the 202 and 211 diameter cans are important and should not be disregarded.

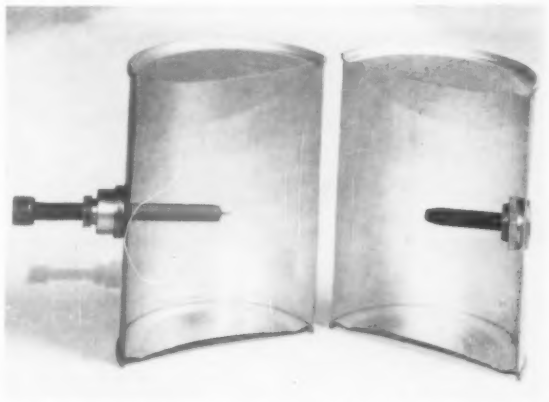

Figure 1. Cross sections of cans with test thermocouples installed. Left: Reference thermocouple mounted through external stuffing box. Right: Non-projecting thermocouple and receptacle.

EXPERIMENTAL

Reference thermocouples made from 38-gauge copper (.004 in. dia.) and 30-gauge constantan (.010) wires were used. The

TABLE 1

Can size	Correction factor: Use on conduction heating products only. Multiply "j" factor by
202 x 214	1.36
211 x 400	1.16
300 x 407	1.10
307 x 409	1.06

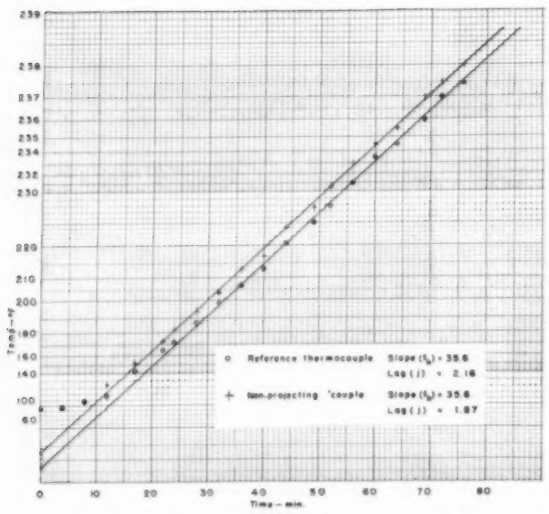

Figure 2. Typical heat penetration curves obtained with 211 x 400 cans.

wires were placed in grooves on opposite sides of a ⅛ in. dia. bakelite rod which was in turn cemented into a ¼ in. O. D. paper base bakelite tube. The hot junction was exposed. The reference thermocouples were held in position by stuffing boxes soldered on the outside of the cans. Only one thermocouple was used in any one can.

The non-projecting thermocouples used were of the all molded, chisel pointed type, made with 30-gauge wire and having exposed hot junctions. The stainless steel receptacles were mounted in the sides of the test cans. All thermocouple hot junctions were located at the geometric centers of the cans.

Pea puree was used as the product in all tests. The initial temperature in each test was approximately 80° F. and processing temperature was 240° F. Come-up times of approximately one minute were corrected by the method of Ball *(2)* in the calculations. Temperature measurements were made with a Brown Electronik Precision Indicator (potentiometer). Average data obtained on replicate runs are shown in Table 2.

TABLE 2

Run no.	Can size	No. of couples of each type in test	Average heat penetration factors			
			Reference couples		Non-Projecting couples	
			j	f_h	*j*	f_h
1A	202 x 214	3	2.26	20.8	1.65	20.8
1B	202 x 214	3	2.18	20.8	1.61	20.8
2A	211 x 400	4	2.14	35.6	1.85	35.6
2B	211 x 400	3	2.16	36.0	1.83	36.0
2C	211 x 400	4	1.93	36.8	1.67	36.8
3A	300 x 407	2	1.86	47.5	1.68	47.5
3B	300 x 407	2	2.00	44.7	1.83	44.7
4A	307 x 409	3	1.78	60.4	1.67	60.4
4B	307 x 409	3	2.20	55.0	2.07	55.0

DISCUSSION

Earlier work by Alstrand *(1)* showed that the size of the thermocouple wire within the range of 24-gauge (404 circular mils area) and 30-gauge (101 circular mils area) and including 30-gauge wire spirally wound on a $^{5}/_{32}$ in. plastic core had little effect on the indicated rate of heating of small cans of conduction heating products. A thermocouple receptacle or nut which extended into the can was found to increase the rate of heating significantly. It may be concluded, therefore, that the 30-gauge and the 38-gauge (16 circular mils area) wires used in the current tests did not contribute appreciably to the error and that the error was due almost entirely to the receptacle projecting into the can.

Jackson and Olson *(4)* showed that the location of the thermocouple hot-junction within a can of conduction heating product influenced the lag factor "j" but not the slope "f_h" of the heating curve. The slope is influenced only by can size for a given conduction heating product.

Thus it would appear that the error caused by the thermocouple receptacle resulted in an effect similar to locating the thermocouple tip away from the can center. The overall effect would be a slight increase in the indicated heating rate at the can center.

The use of the proper correction factors, where needed, should be satisfactory for all conventional heat penetration studies. However, for theoretical studies involving the temperature distribution within a small container of conduction heating product, insertion of the thermocouple through an externally mounted receptable would be preferable.

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The Influence of Environment on Lysozyme Activity in Shell Eggs[a]

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(Manuscript received August 5, 1955)

Time, temperature, and pH of the albumen were studied in relation to lysozyme activity in stored shell eggs. The effects of these factors on bacterial infection of eggs was also considered.

It is well recognized that there are several bacteriostatic properties in eggs. These defenses of the egg against microbial invasion have been classified as both physical and chemical in nature *(15)*. The shell, shell membranes, conalbumin, lysozyme, avidin, ovomucoid, and high pH levels are all known to exert inhibitory action on bacteria.

Since Fleming's report *(10)* on lysozyme in 1922, considerable attention has been focused on this substance. The majority of investigations have dealt with characterization of the enzyme and its possible role in deterioration of quality of eggs during storage. The object of the present study was to evaluate the relation between microorganisms and the bacteriostatic properties of eggs with a view toward obtaining information applicable to the improvement of keeping quality. Environmental factors, such as time and temperature, and the pH of the albumen were studied in relation to the lysozyme activity in stored shell eggs, and the effects of these factors on the bacterial infection of eggs were also examined.

EXPERIMENTAL PROCEDURE

Eggs used in these experiments were collected from trapnests in the poultry house, refrigerated overnight, and placed under desired storage conditions the day after they were laid. All eggs selected were clean and of uniform weight (50 to 60 g.) and shape. They were shown to have sound shells, as determined by candling. Eggs to be stored were placed on racks in desiccators containing a saturated solution of KCl. This salt solution provided a relative humidity of approximately 86% in the range of temperature employed. The desiccators were sealed and held in refrigerated rooms or incubators until the eggs were examined. Temperatures of storage were 1.5°, 10°, and 25° C. Fluctuations during holding did not exceed 1° C. above or below these temperatures.

For lysozyme assays, the albumen from 30 eggs was pooled, and blended in accordance with the method of Carlin and Ayres *(4)*. Pooling was considered to be desirable in order to facilitate sampling. A sample of albumen from 30 eggs gave more reproducible results than those obtained by the use of individual eggs. There is still some controversy in the literature regarding the constancy of the amount of lysozyme in egg white from different hens *(1, 5, 11, 18)*. Therefore, it was believed that a composite sample would minimize possible individual egg differences, as well as provide an adequate amount of albumen for each assay.

Lysozyme activity was determined by a modification of the turbidimetric method of Boasson *(3)* and similar to techniques reported by other investigators *(5, 9, 16, 18)*. Crystalline lysozyme, derived from egg white, was supplied by Armour and Company (lot 381-187). Lysozyme standards were prepared by dilution to concentrations of 0.01, 0.005, and 0.0025 mg. per ml. Egg white unknowns were diluted 1:1000; the initial 1:10 dilution was made in 0.15 M NaCl *(11, 6)*. Turbidity measurements were performed using the Coleman Model 10S and the Beckman Model D spectrophotometers at 450 mμ. The concentration of rehydrated *Micrococcus lysodeikticus* cells, obtained from the Difco Laboratories, was adjusted so that the transmittance of initial readings before lysis was 20 to 25%. The rates of lysis of the cell suspensions in lysozyme standards were compared with those for the bacterial suspension in diluted egg white. Levels of lysozyme in egg white were calculated as indicated by Cotterill and Winter *(5)* and expressed as lysozyme activity based on total solids. Total solids were determined by oven-drying and from refractive index *(2)*.

For studies on incidence of infection of egg contents, several methods were tried in an attempt to disinfect the shells *(12, 13, 20)* prior to breaking-out. The procedure finally adopted was as follows:

Eggs were rinsed in running tap water at 45° C. and placed in an egg-sanitizer solution containing quaternary ammonium chlorides for 3 minutes at 45° C. The eggs were drained and dipped in a solution of $HgCl_2$ (1:1000) for 30 minutes. The eggs were drained again, dipped in ethyl alcohol (70% by weight) at 45° C. and flamed. After flaming, eggs were placed on sterile flats until opened. This method was similar in effect to that reported by Forsythe *et al. (12)* in that approximately 50% of the eggs examined were found to have sterile shells.

The eggs then were broken and the contents of each were emptied into individual jars containing 25 ml. of double strength Fluid Thioglycollate Medium (Difco) in accordance with the method of Wolk *et al. (20)*. The broth contained 2% Tamol N; the latter was added before sterilizing the medium and served to neutralize the quaternary ammonium salts present in the sanitizer. After shaking until the egg contents were thoroughly mixed with the broth, jars were incubated at room temperature (23 to 27° C.) for 4 days. At the end of the incubation period, streaks were made on the Phenol Red Agar medium described by Forsythe *et al. (12)*. Tubes were incubated for another 4 days, at which time confirmation of infection was obtained by microscopic examination of smears taken from the slants.

Measurements of pH were performed using the Beckman Model H-2 pH meter.

RESULTS AND DISCUSSION

During the course of the work, analyses were made of the lysozyme activity of pooled samples of fresh egg albumen. The mean value for lysozyme activity was 3.7% of the total solids, with a standard error of about 0.1% and confidence interval of 3.5 to 4.0% ($P = 0.05$). Since the eggs were analyzed throughout a period of six to seven months, some seasonal variation may exist *(18)*. However, fresh eggs and stored eggs all came from the same hens, providing a basis for comparing temperature effects.

Changes in lysozyme activity of eggs stored at 1.5°, 10°, and 25° C. are shown in Figure 1. Eggs held at 25° C. had a rather rapid increase in activity with a peak at 7 days; this was followed by a pronounced decline during the remainder of the 21-day period. The

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points that may have been important were the 7-day peak and the low point at 21 days. At 10° C., there appeared to be a gradual increase in activity, followed by a slow decrease. However, with the exception of the 14-day value, these points fell well within the confidence interval estimate for fresh eggs. There were no marked differences in lysozyme activity of shell eggs

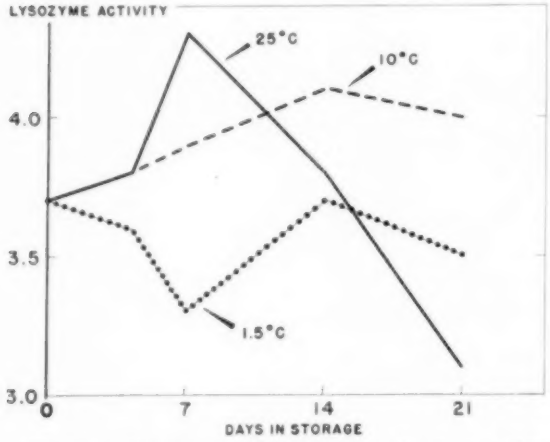

Figure 1. Lysozyme activity of eggs stored at 1.5° C., 10° C., and 25° C.

held at 1.5° C. for 21 days. Further replications have indicated that the average activity after 7 days in storage was about 3.6%, rather than the value of 3.3% shown on the curve. With regard to the high holding temperature, the difference between 3.7% activity for fresh eggs and 3.1% for eggs kept for 21 days was a decrease in activity of about 16%. With shell eggs held at 22° C. for 15 days, a decrease in lysozyme activity of approximately 17% was observed by Feeney *et al. (9)*. These workers believed that an apparent loss in activity of lysozyme did not prove that such activity was destroyed. Rather, they noted that decreased activity may have resulted from unavailability due to the formation of complexes between lysozyme and ovomucin. Still another type of complex formation was studied by Ehrenpreis and Warner *(8)* who observed the interaction of lysozyme with conalbumin. Perhaps these phenomena may have accounted for the observed decrease in activity on prolonged storage at 25° C.

As stated previously, one of the objects of this work was to study the relation between bacterial infection and antibacterial activity of shell eggs. Curves representing the degree of infection of eggs kept at 1.5°, 10°, and 25° C. are shown in Figure 2. The degree of infection proceeded in a rather straightforward manner after the first week, and depended upon the temperature of storage. Referring to the curves for lysozyme activity (Figure 1), there is an apparent peak in activity at 7 days in eggs held at 25° C., yet the incidence of infection at that time was high (Figure 2). The degree of infection increased at all temperatures of storage, indicating that lysozyme activity was of little or no importance in influencing the percentage of eggs infected.

In this connection, mention should be made of a recent report by Wilcox and Daniel *(19)*. These authors reported that when the concentration of lysozyme was raised to 2.5 mg. per ml., no apparent enzyme activity was observed. They stated that this concentration is approximately half that of lysozyme in egg white. Further, they noted that undiluted egg albumen demonstrated reduced lysozyme activity when compared with low concentrations of the crystalline enzyme in solution.

Although *Micrococcus lysodeikticus* is one of the test organisms employed in the lysozyme assay, it is of no particular interest as a causative agent of egg spoilage. Other trials were performed in a manner similar to that previously described, using several strains of *Pseudomonas* bacteria isolated from eggs showing green fluorescence. Under the test conditions, no lysis of the *Pseudomonas* strains was produced by lysozyme or by egg albumen. There are, of course, several variables that may influence such tests; for example, the concentration of cells may have been too great. From the practical aspect, however, eggs characterized as green fluorescent rots may be infected with high numbers of *Pseudomonas* cells that originally may have developed from a small inoculum, and lysozyme notwithstanding, still proliferated sufficiently to cause spoilage. In any event, as the assays are ordinarily conducted, the *Pseudomonas* bacteria were not similar to the test organism with respect to lysis. Myerholtz and Hartsell *(14)* observed that special conditions were

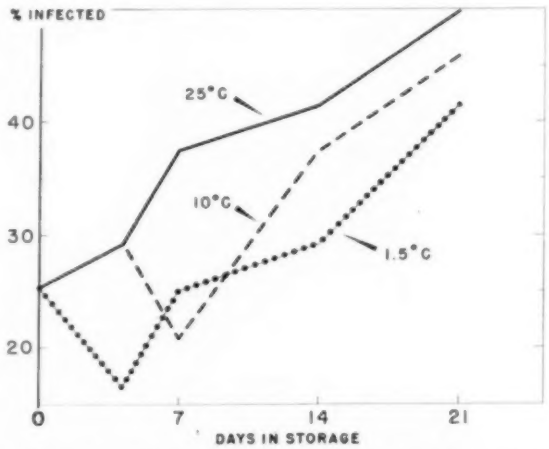

Figure 2. Percent of eggs infected during storage at 1.5° C., 10° C., and 25° C.*

*** Twenty-four to ninety-six eggs sampled at each point. All eggs were one day old at the beginning of storage.**

necessary for lytic activity of lysozyme when tested with *Pseudomonas fluorescens* and other Gram negative bacteria.

Much information has been reported concerning optimum conditions for lytic activity of lysozyme. With regard to pH, Smolelis and Hartsell *(17)* reviewed previous investigations and placed the optimum pH for

visible lysis at 6.6. Dickman and Proctor *(7)* observed a broad pH optmium in the range 5.9 to 6.3.

Changes in pH of albumen from eggs kept at the test temperatures are shown by curves in Figure 3. The pH reading for 0 days storage was determined on eggs less than 2 hours old. All others were placed in their respective holding conditions the morning after laying. These eggs had remained in the nests for various periods of

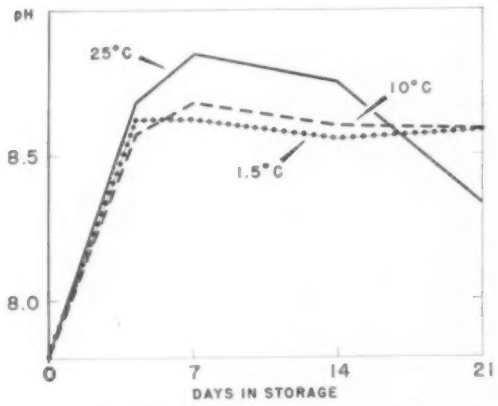

Figure 3. Changes in pH of albumen from eggs stored at 1.5° C., 10° C., and 25° C.*

*** Each point is the mean of 3 samples of 15 pooled whites per sample. Eggs placed in storage one day after collection.**

time before collection which may account for the apparent rapid rise in pH at the lower holding temperature.

From an initial average pH of 7.8 for fresh eggs, a rapid increase was noted with all storage temperatures; the greatest rise occurred at 25° C. At this temperature, the pH of the albumen tended to decrease from a value near 9.0 as storage progressed. At 1.5° C. and 10° C., the pH did not vary greatly, but remained between 8.5 and 8.7 throughout the 21-day period. Alkaline pH values have been found to be less favorable for lytic activity of lysozyme than those at approximate neutrality *(7, 17)*, but for egg albumen, the pH curves roughly followed the order of the curves for lysozyme activity (Figures 1 and 3). These data indicated that increase or decrease in lysozyme activity was not affected by the pH of the white.

Also, no apparent relation existed between infection of the egg contents and the pH of the albumen. Regardless of the direction of change in pH, the degree of infection increased at all temperatures throughout the storage period.

SUMMARY

Lysozyme activity of shell eggs appeared to increase early during storage at 25° C. and then declined during the remainder of the 21-day period. Differences in activity were not as pronounced at 10° or 1.5° C. as they were at 25° C. Lysozyme activity was not related to the incidence of bacterial infection of shell eggs stored at the specified temperatures, or to the pH of the albumen.

Pseudomonas bacteria responsible for green fluorescence in shell eggs were not lysed or inhibited in growth by either lysozyme or egg albumen.

The pH of the albumen did not affect the percentage of shell eggs infected during storage at any of the temperatures employed.

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The Monomolecular Surface Film Method for Determining Small Quantities of Yolk or Fat in Egg Albumen[a]

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(Manuscript received August 23, 1955)

During the normal commercial egg breaking and separating operation minute quantities of yolk inadvertently get into the egg white portion. The percentage of this contaminating yolk in whites depends upon the condition of the eggs as well as upon the method and the amount of care used in the operation. Yolk content from a careful operation can be as low as 0.01% and from a poor one as high as 0.20%.

Because the presence of yolk affects the functional quality of egg white the need for a reliable control test has long been recognized. Since only minute quantities of yolk are involved, the amount cannot be detected by ordinary control methods for determining fat. Although Cook and Mehlenbacher *(1)* devised a method for extracting cholesterol, a normal constituent of yolk, from egg white and determined its quantity by a colorimetric procedure, this method, which requires closely regulated laboratory conditions, has been difficult to use as a quality control test.

Heinemann and Rohr *(2)* developed a micromethod for determining the fat content of skimmilk. The fat was extracted from the sample and then a given proportion spread as a monolayer on an acid solution. The amount of fat was obtained by measuring the area of the spread. The investigators found this method to be useful for routine testing of milk products with low fat content, requiring only 12 minutes for each determination. The work reported herein is a study of this method *(2)* as modified for determining yolk, or fat, in egg white.

EXPERIMENTAL

Materials and apparatus. The following reagents and solutions are used:

Ethyl alcohol, 95%.
Ethyl ether, U.S.P.
Petroleum ether, b.p. 30-65° C., ACS specifications.
Ammonia solution, 2% (aqueous).
Acetic acid solution, 0.2% (aqueous).
Oxidized lubricating oil.

Figure 1 shows a set-up of the apparatus for this test. An 8 in. pie dish, designated by the numeral 1, is used for the acetic acid solution onto which the fat film is spread. The outside of the dish is painted with black enamel and covered with a layer of paraffin to protect the enamel coat. The pie dish is placed in a square pyrex baking dish and the height adjusted so that the pie dish is separated from a tracing glass by about ⅛ in. The tracing glass, 2, is a piece of single strength window pane, 12 x 12 in., with the edge taped to allow safe handling.

The oil used to prepare the surface film is a lubricating oil oxidized by heating for about 3 hours at 300° F. with air bubbling through at the same time. A one-milliliter tuberculin syringe, 3, fitted with a No. 27 hypodermic needle is used to deliver the oil to the surface of the acid solution.

[a] Presented at the Fifteenth Annual Meeting of the Institute of Food Technologists, Columbus, Ohio, June 15, 1955.

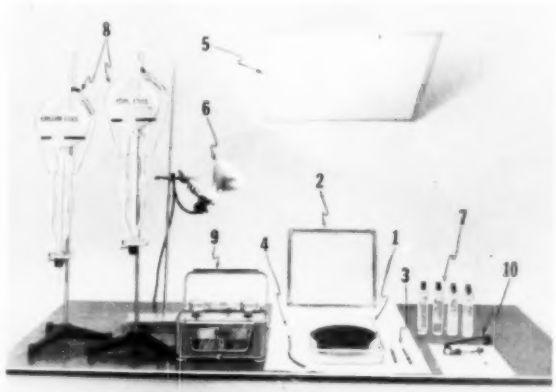

Figure 1. Apparatus used for the monomolecular surface film test for determining fat in egg whites.

The pipette, 4, used for delivering the ether solution of fat to the spreading surface is made from a Breed and Brew pipette by drawing out the tip to about 1.5 mm. The pipette is calibrated with benzyl benzoate on a "to deliver" basis. For this work it was calibrated to deliver 0.0072 ml.

For the light source a piece of flex-board, 5, about 12 x 24 in., is painted white and placed directly above and at a slight angle to the tray. A 150-watt spot light, 6, is directed to shine on the flex-board until a uniform white reflection can be seen in the dish filled with the acetic acid solution.

Other equipment shown in Figure 1 are 4 oz. oil sample bottles, 7, two 25-ml. Machlett pipettes, 8, a torsion balance, 9, a 5 cm. diameter aluminum dish fitted with a lid having a ⅜ in. hole, and a planimeter, 10, for measuring the area of the spread. In addition to this equipment a hot plate and vented hood are required.

Method. Of several modified methods tested the following procedure was found to give the most satisfactory results:

Weigh 10 g. of liquid egg albumen into a 4 oz. oil sample bottle. Add 25 ml. of 2% ammonia solution and mix thoroughly with the albumen. Add 45 ml. of a mixture of ethyl alcohol and ethyl ether (20 ml. ethyl alcohol + 25 ml. ethyl ether). The protein coagulates when this mixture is added and the bottle is stoppered and shaken vigorously for one minute. Add 25 ml. of petroleum ether and mix for several seconds and then allow the bottle to set for ½ to 1 minute. If no separation occurs add 5 ml. ethyl alcohol and invert the bottle several times. This will generally break the emulsion and cause separation to take place. Twenty-five milliliters of the ether layer is then drawn into a 25-ml. pipette and transferred to an aluminum evaporating dish. The dish is placed on a hot plate and the ether evaporated to dryness. The dish is then cooled in water, wiped dry with a towel, and covered with a lid with a hole large enough to insert the Breed and Brew pipette. The dish is placed on a torsion balance and petroleum ether is measured into it slightly in excess of 2.5 g. The dish is rotated gently in order to cause solution of the fat. At this point the surface of the acetic acid solution is prepared. The surface is wiped clean by passing an absorbent towel over it, and the oxidized oil is delivered to the surface until a third order green is reached. Returning to the dish the weight of petroleum ether is adjusted to 2.5 g. After rotating the dish gently the Breed and Brew pipette is inserted and a

quantity of the solution to be spread is withdrawn slightly above the mark. The tip of the pipette is wiped with a clean towel and the solution brought back to the mark. The tip of the pipette is then held at the prepared surface and the liquid is expelled gently, blowing the last drop over the surface and again touching the tip to the center of the spread (Figure 2). The outline

Figure 2. Method of spreading monolayer of fat on surface of acetic acid solution.

of the fat film area is traced onto the glass, retraced onto paper, and the area measured with a planimeter. Three tracings are generally taken of one spread and the areas averaged.

Blanks are run at frequent intervals in which distilled water is substituted for egg white. The area of this spread is generally between 0.25 and 0.35 sq. in.; this value is subtracted from the average area when egg white is used.

RESULTS AND DISCUSSION

The spreading ability of egg fat was tested for several samples of fat obtained from egg yolk by an ethyl ether—petroleum ether extraction. The fat was redissolved in petroleum ether in concentrations from 0.25 to 2.5 mg. per ml. and 0.0072 ml. aliquots of these solutions were spread. From the measured areas spreading coefficients were determined using the following formula:

$$\theta = \frac{(\text{Con. egg fat, mg./ml.})\ (\text{ml. spread})}{(\text{Area, in.}^2)}$$

Typical results used in determining the spreading coefficient of egg fat are shown in Table 1. It is seen that average coefficients obtained were all close to the same figure, regardless of fat level. The largest error—noted at the high concentration (2.5 mg./ml.)—was probably due to the fact that there was always a slight movement at the surface of the acid solution after the spread had been made. For a large area the shape of the spread changed somewhat before the tracing could be completed. Because of this, the largest concentrations were disregarded when determining the final average spreading coefficient. Using only the lower concentrations of fat (0.25 and 0.50 mg./ml.) the overall mean spreading coefficient was found to be 0.98 with a coefficient of variation of 4.4%. The latter figure indicates the error which can be expected from spreading, tracing, and measuring area alone and is therefore the minimum error obtainable by this method.

TABLE 1
Determination of spreading coefficient of egg fat

Concentration egg fat in petroleum ether	Equivalent yolk concentration in egg albumen	Average[1] area spread using 0.0072 ml.	Spreading coefficient	Coefficient of variation
(mg./ml.)	*(%)*	*(in.²)*	*(γ/in.²)*	*(%)*
0.25	0.075	1.88	0.96	3.6
0.50	0.150	3.60	1.00	4.1
2.50	0.750	17.30	1.04	6.3

[1] Average of 10 spreads.

The spreading coefficient of 0.98 for egg fat is slightly higher than the 0.90 for milk fat found by Heinemann and Rohr *(2)*.

The formula for computing the egg fat content of egg albumin is as follows:

$$\text{Percent fat} = \frac{(\text{Area, in.}^2)\ (\theta,\ \gamma/\text{in.}^2)\ (\text{ml. ether solution}) \times 100}{(\text{ml. spread})\ (\text{wt. sample, g.})\ (10^6\ \gamma/\text{g.})}$$

$$= (\text{Area, in.}^2)\ \frac{(0.98\ \gamma/\text{in.}^2)\ (3.94\ \text{ml.}) \times 100}{(0.0072\ \text{ml.})\ (5\ \text{g.})\ (10^6\ \gamma/\text{g.})}$$

$$= (0.0107)\ (\text{Area, in.}^2)$$

For convenience the results given herein are reported as percentage of equivalent yolk. The yolk is arbitrarily taken as a 45% solids yolk with an extractable fat content of 26.5%. Thus, the formula for computing yolk content in egg white is given as follows:

$$\text{Percent yolk} = \frac{\%\ \text{fat}}{0.265}$$

$$= \frac{(0.0107)\ (\text{Area, in.}^2)}{(0.265)}$$

$$= (0.0405)\ (\text{Area, in.}^2)$$

In order to test the effectiveness of recovering egg fat by this method yolk standardized at 45% solids was added in known concentrations to samples of egg white. These were thoroughly blended on a Waring blender to insure as homogeneous a sample as possible. These samples were tested by two different operators. The results are shown in Table 2. Although the coefficient of variation was close to the same for both operators at each concentration of yolk, results by operator No. 1 (a man) were found to be consistently higher than by operator No. 2 (a woman). Where the first operator obtained close to 100% recovery of fat from the albumen, the second operator obtained approximately 85-90% recovery. This indicates that one minute of shaking the ether-egg white mixture by hand may not be sufficient for some persons to obtain complete extraction. Using a mechanical shaking device may be an answer to this problem.

It was felt that holding egg white under certain conditions may affect the distribution of fat and therefore the results obtained by this method. To test whether or not this was true, egg white samples with various yolk

TABLE 2
Recovery of egg yolk from egg albumen by the monomolecular surface film method

Sample	Operator No. 1			Operator No. 2		
	Average[1] total yolk	Coefficient of variation	Added yolk recovered	Average[1] total yolk	Coefficient of variation	Added[1] yolk recovered
	%	%	%	%	%	%
Egg White No. 9 — no yolk added	0.030	16.3	0	0.028	16.1	0
Egg White No. 9 + 0.05% yolk	0.081	10.9	0.051	0.071	13.0	0.043
Egg White No. 9 + 0.10% yolk	0.131	9.5	0.101	0.117	11.0	0.089
Egg White No. 9 + 0.15% yolk	0.191	7.5	0.161	0.163	8.7	0.135

[1] Average of 9 determinations.

TABLE 3
Effect of holding conditions on the recovery of egg yolk from egg albumen by the monomolecular surface film method

Sample	Yolk[1]				
	No storage	Held as liquid at 35° F.			Frozen at −10° F. for 1 month
		3 days	6 days	10 days	
	%	%	%	%	%
Egg White No. 10 — no yolk added	0.017	0.015	0.016	0.023	0.022
Egg White No. 10 + 0.05% yolk	0.050	0.048	0.052	0.057	0.058
Egg White No. 10 + 0.085% yolk	0.100	0.099	0.101	0.115	0.108
Egg White No. 10 + 0.135% yolk	0.149	0.156	0.155	0.154	0.154
Egg White No. 11 — no yolk added	0.058	0.064	0.061	0.065	0.062
Egg White No. 11 + 0.06% yolk	0.121	0.127	0.134	0.115	0.124
Egg White No. 11 + 0.12% yolk	0.184	0.178	0.176	0.168	0.177
Egg White No. 11 + 0.18% yolk	0.259	0.251	0.264	0.234	0.251

[1] Average of 4 determinations.

concentrations were held both as a liquid under refrigeration at 35° F. and in the frozen state at —10° F. It is seen in Table 3 that holding egg white under these conditions has little or no effect on the yolk content as determined by this method.

The standard deviation and coefficient of variation obtained when testing several egg white samples at different yolk concentrations is shown in Figure 3. Each point represents 9 replications. It is seen that standard deviation increases from a value of 0.002% at a mean of 0.01% yolk to 0.020% at a mean of 0.25%, while coefficient of variation changes from 18.7% to 8.0%. Several possible sources of error by this method are listed below:

Non-uniform distribution of fat throughout the egg white sample.

Insufficient extraction of fat.

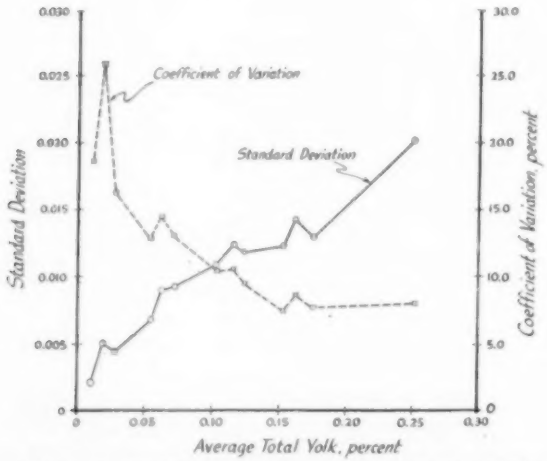

Figure 3. Standard deviation and coefficient of variation obtained at various concentrations of yolk in egg white.

Error in measuring out sample, solvents, and solutions.

Missing certain fat-containing areas on the side of the aluminum dish when redissolving the extracted fat in petroleum ether.

Accuracy of the weight of 2.5 g. petroleum ether when taking an aliquot sample with the micro-pipette.

Contamination of equipment with fats or oils. (Note: If a Machlett Pipette is used for delivering the ether solutions no lubricant should be used in the stop cock.)

Temperature of the spreading surface is apparently of little significance between 20° C.-30° C.

Error in tracing the spread.

SUMMARY

The method of Heinemann and Rohr for determining microquantities of fat in skimmilk has been adapted for determining small quantities of yolk, or fat, in egg white. In this method fat is extracted by using a combination of ethyl and petroleum ethers; an aliquot of the fat redissolved in petroleum ether is spread as a monolayer on the surface of an acetic acid solution. The area of the spread is a measure of the quantity of yolk present.

The spreading coefficient of egg fat was determined and the method was shown to give good recovery of egg fat from egg white even after holding samples for extended periods at both 35° F. and —10° F.

Errors which may cause variation in results have been pointed out.

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Uses of Gelsoy in Prepared Food Products[a]

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Gelsoy, a bland-tasting water-soluble proteinaceous product isolated from soybean meal, shows promise as a water-binding material in prepared, comminuted meat products, such as frankfurters, meat loaf, and canned meat. Sodium hexametaphosphate increases the water- and fat-binding capacity of Gelsoy. A spray-dried mix consisting of Gelsoy, nonfat dry milk solids, sugars, vegetable oil, vegetable gum, and modified starch, when reconstituted with water is frozen directly without further homogenization to provide a low-fat frozen confection of good quality and flavor.

Gelsoy, the name given to a water-soluble proteinaceous product isolated from defatted soybean meal, is produced by treating the meal with ethanol *(1)* to remove the beany flavor usually associated with soybeans. The ethanol treatment also modifies properties of the protein to improve its aerating, emulsifying, and gelling characteristics *(2)*. The present report includes a brief outline on the preparation and properties of this product and indicates its potential usefulness in certain specialty food products.

Gelsoy *(3, 4)* is prepared from specially prepared dehulled soybean flakes from which the oil has been removed with hexane and which have then been otherwise processed to maintain maximum solubility of their protein *(5)*. On an 8% moisture basis the flakes should contain 50 to 55% protein, 6.5% ash, and 15-20% soluble carbohydrates.

A major specification for soybean flakes used in making this product is based on percentage solubility of the nitrogenous components in water by a method described by Belter and Smith *(5)*. This method is used by many soybean processors to control toasting of their meal and is known as the Nitrogen Solubility Index (NSI).

It is possible to produce soybean flakes with an NSI of 90, indicating that 90% of their nitrogenous compounds are soluble in water; however, in the Gelsoy process, flakes with values as low as 65 can be used successfully.

Processing soybean flakes for Gelsoy includes five principal steps: (a) Countercurrent washing of the flakes with 90-95% ethanol, (b) desolventizing the flakes in a flash-type vapor-phase desolventizer *(6)*, (c) extraction of the water-soluble components from the flakes by a counterflow batch process in which the first extract passes over a second and third batch of flakes to increase its dissolved solids content, (d) clarification of the extract by passing through a screen and a centrifuge, and (e) spray-drying of the extract to recover the Gelsoy.

The efficiency of the process depends upon the amount of water-soluble protein in the original flakes, concentration and temperature of the alcohol used in washing the flakes, desolventizing of the flakes in a manner to minimize denaturation of the protein, and use of alkali (pH about 8.0) in the extracting solution to assist in dissolving the protein. A yield of 50 to 60%, based on the original weight of the flakes, is obtained. It should be noted that processing for Gelsoy does not involve the enzymatic treatment of the protein as in preparation of soy-aerating products *(7, 12, 15)* now on the market.

Properties. Gelsoy is a yellowish powder of low density, soluble in water to about 50% concentration at 77° F.; this solution shows no marked increase in viscosity *(2)* until the concentration increases to 40%. Analysis shows 50-60% protein (N x 6.25), 1% reducing sugars, 15-20% hydrolyzable sugars, 9% ash, and 8% moisture. The sugars *(13)* are known to consist approximately of 55% sucrose, 10% raffinose, and 35% stachyose.

On heating a solution of approximately 10% Gelsoy to 90° C. (194° F.) it forms an irreversible, self-supporting, opaque gel *(8)*. The gelling property appears to depend on the denaturating action of the alcohol in washing the flakes. The alcohol also extracts from the flakes a small amount of lipid material which tends to interfere with gelation. The total amount of material extracted with alcohol is about 1% on weight of the flakes.

Another property of this product is its foaming and whipping capacity. The stability of the foam is greatly improved by preheating the water solution of Gelsoy for a few minutes to near boiling temperature and by the addition of stabilizers such as locust bean gum. For example, when 20-40 g. of the product are added to about 300 ml. of water, heated to boiling temperatures and vigorously whipped, about 5 liters of foam is developed; the foam will stand about 12 minutes in a funnel before it starts to weep. On adding a suitable amount of syrup it develops into a meringue of good flavor and texture, but does not peak as well as egg white. It was found that Gelsoy foams could be fairly

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well stabilized under browning conditions in the oven but its comparison with egg white was not good enough to suggest replacement in meringues.

Another interesting property of Gelsoy is its softening action on bread. Glabe *(9)* and Ofelt, Smith, and Belter *(14)* found that at a 1% level it is as effective in softening bread as 0.4% monoglycerides; however, higher levels of Gelsoy did not give any further decrease in bread firmness. The work of Ofelt, Smith, and Belter showed that a preparation called "soybean whey" also reduced crumb firmness, and since the whey is very low in protein the results indicate that the crumb-softening action of the product may be effected by some component other than the protein in these soy preparations.

The water-soluble protein content of Gelsoy and its capacity, under certain conditions, to hold 10 times its weight of water suggested its utilization in sausage-type meats for prevention of water and fat separation. Also, its foaming properties suggested its application for the control of overrun in low-fat frozen confections. This report describes the results of investigations on the use of this product in these specialty food products.

Use in sausage and related meat products. The commonest types of sausage and prepared meats are frankfurters, bologna, and meat loaves. Generally these have been considered to be "emulsion-type" products wherein the water is emulsified with the fat and protein of the meat. Most all sausage is conceded to require the presence of beef muscle, beef fat, beef trimmings, and pork trimmings; the latter generally contain fairly high percentages of fat. Some manufacturers make frankfurters from beef products only, while others use varying quantities of beef and pork products. The high fat composition of frankfurters often leads to fat and water separation during and after processing and thus it is the practice to use "binding" materials to assist in stabilizing the "emulsion." These materials have been nonfat dry milk solids, tapioca, and potato starches, corn and wheat flours, either gelatinized or ungelatinized, and brewers' dried yeast. Federal regulations limit the addition of such binding materials individually or collectively to 3½%.

Sausage manufacture is still an art and is dependent upon the skill and experience of the operator. It has not been established what factors are responsible for fat and water separation in frankfurters and bologna. There are differences of opinion as to whether the sausage is truly an emulsion. Certainly day-to-day variation in quality of raw materials plays a part in maintaining emulsion-type stability. Temperatures of the meat mass during grinding and chopping, the degree of grinding and chopping, the lapse of time between the chopping operation and stuffing of the casings, the variations in the smokehouse temperature, all are undoubtedly factors. Research to uncover factual data has yielded little in the way of truly reliable facts. Indeed, it has often uncovered confusing data as to whether sausage is actually an emulsion of fat in water or vice versa, or only fat suspended in a protein-water system. One of the confusing observations has been that emulsifier-type chemicals show little improving effect upon sausage stability; and the presence of an emulsifier often tends to produce poorer rather than better quality products. Studies which are being reported here recognize all of these uncertainties and do not in any way attempt to prove that the addition of one ingredient is a cure-all for the difficulties facing the sausage industry.

EXPERIMENTAL

Sausage. In the present investigation, a laboratory method of making sausage, which includes all the steps used in commercial production, was developed; the method was primarily designed for testing emulsion stability in sausage.

Preparation. Obviously a wide selection of sausage formulas is possible. To reduce to the simplest formula for laboratory work a combination of 36.7% of beef lean, 18.3% of pork lean, and 45% of pork fat was employed.

The beef lean and the pork lean were carefully and thoroughly trimmed by hand so that no fatty tissue was present except that which was interspersed with the lean tissue. For each 100 g. of the above composition 2.0 grams of salt and curing compounds consisting of 0.4 g. potassium nitrate, and 0.04 g. of potassium nitrite were added.

The meat previously cut into 1-inch pieces was mixed by hand with the above chemicals. It was then ground through an ordinary meat grinder using a $^{3}/_{16}$-inch die. The resulting ground meat was stored at 40° F. for several hours.

Chopping. Small batches of meat were selected for laboratory test operations as this method gave best uniformity of raw material. Uniformity of chopping operations was attained in a Waring blender, which was found to give an action fairly comparable to that of an ordinary commercial silent cutter. The chopping required about 3 minutes, but was carried to a point where the appearance of the batch indicated good emulsification of the fat and water. This is similar to the practice normally used in plant operations. Experience showed that if the chopping in the Waring blender was carried to a critical point, good differentiation in separation of fat in frankfurters could be observed. Ice water and other components were added in the chopper (Waring blender), as is done commercially.

Stuffing. The sausage mix was stuffed into Visking casings by means of a hand-operated pressure cylinder. The casings were then tied off into conventional lengths.

Heat treatment in lieu of smokehouse. Normally the sausage would be subjected to a smokehouse operation. For laboratory purposes, the sausages are subjected to similar temperature combinations, but without the presence of smoke. This was done in a thermostatically controlled oven held at the following temperatures:

135° F. or 3 minutes, raised to
150° F. for 30 minutes, raised to
165° F. for 60 minutes, raised to
180° F. until the interior temperature of the frankfurters reached 150° F., which should not take longer than 20 minutes.

Cooking. The frankfurters were removed from the heat chamber and plunged into water at 160° F. for 5 minutes.

Cooling. The frankfurters were then cooled under running tap water for about one-half hour, hung in a refrigerator at 40° F. for approximately 16 hours, after which examination was made.

The above method was found to give results which could be duplicated readily. The use of small batches of meat made possible very close trimming which reduces the variable of fat versus lean; it also eliminates day-to-day variations in meat, since one batch supplied material for several days. Using this method a series of tests was made to compare the effectiveness of 3% of nonfat dry milk solids with 1% and 0.5% of Gelsoy. Examination of the sausages after storage of 16 hours at 40° F. consisted of cutting the sausages lengthwise and observing the degree of free water and/or fat which was shown under the

surface casing and which had collected into pockets in the sausage itself.

RESULTS

The results of this series of experiments are shown in Table 1.

The above series of frankfurters contained no seasoning and had no detectable flavor differences.

The results of the above experiments indicate that the Gelsoy apparently acts as a water-binding material in frankfurter-type sausage similar to nonfat dry milk solids.

The use of sodium hexametaphosphate as an aid in promoting water-binding properties in sausage is of current interest and use. The effect of using this salt in combination with Gelsoy was next determined. For this purpose a mixture of 50% Gelsoy, 10% sodium hexametaphosphate, and 40% wheat starch dextrine as a carrying agent was used. Each of the ingredients was tested singly to determine its effect and then the entire combination was employed. The results are given in Table 2.

TABLE 1

Binding effect of Gelsoy on fat and water in sausage

No. of series examined	Sample	Ice water added	Separation of water and fat[1]
		%	
5	Control (no binder)	36	Excessive
5	Nonfat dry milk solids, 3%	39	Moderate to slight
5	Gelsoy, 1%	39	Moderate to slight
2	Gelsoy, 0.5%	39	Moderate to excessive

[1] Scale: Excessive—moderate—slight—none.

TABLE 2

Effect of a combination of sodium hexametaphosphate and Gelsoy on water- and fat-binding characteristics

	Ice water added	Separation of water and fat average of two experiments[1]
	%	
Control (no binder)	36	Excessive
Nonfat dry milk solids, 3%	39	Moderate
Gelsoy, 1%	39	Slight
Gelsoy, 0.5%	39	Excessive
Sodium hexametaphosphate, 0.1%	39	Moderate
Wheat starch dextrine, 0.4%	39	Excessive
Gelsoy-phosphate-dextrine, 1.0%[2]	39	Slight

[1] Scale: Excessive—moderate—slight—none.

[2] Gelsoy 50%, sodium hexametaphosphate 10%, wheat starch dextrine 40%.

These tests show that a combination of sodium hexametaphosphate with Gelsoy increases the efficiency of Gelsoy as a water- and fat-binding agent.

Meat loaf. Experiments were also made on typical commercial-type meat loaves. The formula was as follows:

Material	%
Beef lean	48.40
Pork lean	33.8
Pork fat	14.5
Salt	1.94
Seasoning	0.48
Sugar	.48
Cure	.40

Preparation of the meat followed the procedure outlined for frankfurters; grinding and chopping were water was added. After coming from the chopper 250 grams of meat was placed in baking pans and baked for 40 minutes at 400° F.

At the end of the baking period and after cooling, the similar. In all experiments, during chopping, 3% of ice free liquid consisting of both water and fat was poured from each pan into individual graduated cylinders, allowed to stand for 1 hour, and measured. The results are given in Table 3. Included in these experiments are tests made with a combination of Gelsoy and hexametaphosphate.

TABLE 3

Binding effect of Gelsoy on fat and water in meat loaves

	Separation		
	Water	Fat	Total
	ml.	*ml.*	*ml.*
Control (no binder)	20	15	35
Gelsoy, 1.0%	17	12	29
Gelsoy, 0.5%	21	14	35
Sodium hexametaphosphate, 0.1%	17	16	33
Wheat starch dextrine, 0.4%	21	15	36
Gelsoy-phosphate-dextrine (5:1:4), 1.0%	18	12	30

It appears that 1% Gelsoy exerts a binding effect on fat and water in meat loaves. Combining the Gelsoy with sodium hexametaphosphate increases its water- and fat-binding capacity so that a smaller quantity of Gelsoy may be employed to obtain the desired effect. Thus 0.5% of Gelsoy combined with the phosphate is equivalent to 1.0% Gelsoy used alone.

Canned meats. In order to further determine the relative value of Gelsoy as a fat- and water-binding material in meat products a series of canned meat experiments was made. "Potted meat," as it is also known, is generally made from trimmings from packing-house operations with very little or no beef muscle, which is normally the important ingredient in cooked sausage. The formulas for potted meats are many and varied. The one selected was as follows:

EXPERIMENTAL

The following materials were used:

	%
Tripe, raw	60.00
Bacon ends	10.00
Beef hearts	10.00
Beef kidneys	10.00
Tongue	10.00
Sodium chloride	2.00
Spice	0.50
Sodium nitrite	.02

Preparation. The weighed meat was cut into small pieces and laid in even, parallel rows on a table. Salt, nitrite, and spices were scattered evenly throughout the meat. The entire mass was then mixed well by hand and put through a meat grinder.

Chopping. Portions of 150 g. each were placed in the Waring blender and chopped for a length of time previously determined to give proper consistency in the finished product. It was found that approximately 3 minutes of chopping with frequent stopping of the machine and scraping down the bowl was required. Three minutes represented the total time the blender was in operation. In the following experiments the variables of Gelsoy, water, and other ingredients were added at the chopping stage. The chopped

product was placed in enameled cans (303 x 109), the cans filled to the brim, and sealed immediately.

Sterilization. Sterilization was accomplished in a pressure cooker at 10 pounds of steam (240° F.) for 1 hour.

Cooling. Normally, cooling of any canned product is accomplished by immersing the cans in cold running water. Two methods of cooling, in air and in water, were used to determine the difference in cooling rate, as indicated by the amount of water and fat separation from the meat product 24 hours after sterilizing and cooling. In both cases liquid separation was measured by pouring off the liquid into graduated cylinders.

RESULTS

The results are given in Tables 4-6.

Tables 4 through 6 show that 1% Gelsoy increases the fat and water binding in this typical potted meat formula. Variations in the formula in the type of fat used show variations in the amounts of fat and water which are exuded. Type of cooling is also a factor in the degree of separation. Sodium hexametaphosphate does not improve the binding properties of the Gelsoy in canned meats.

TABLE 4

Effect of Gelsoy on fat and water separation in potted meat—comparison of cooling methods

	Additional water	Cooling method	Fat and water separation
	%		*ml.*
Control	—	Air	13.5[1]
			15.5
1% Gelsoy	—	Air	15.0
			14.0
1% Gelsoy	3	Air	11.0
			9.5
Control	—	Water	20.5
			17.5
1% Gelsoy	—	Water	16.0
			18.5
1% Gelsoy	3	Water	12.0
			13.5

[1] Duplicate cans.

TABLE 5

Effect of Gelsoy on fat and water separation in potted meat—influence of type of fat

	Additional water	Cooling method	Fat and water separation
	%		*ml.*
Beef fat replacing 10% of tripe			
Control	—	Air	20.0
			17.0
1% Gelsoy	—	Air	14.5
			15.0
1% Gelsoy	3	Air	18.5
			16.0
Control	—	Water	15.0
			14.5
1% Gelsoy	—	Water	15.0
			14.5
1% Gelsoy	3	Water	17.5
			17.5
Pork back fat replacing 10% tripe			
Control	—	Air	15.0
			13.0
1% Gelsoy	—	Air	11.0
			9.5
1% Gelsoy	3	Air	8.0
			6.0
Commercial lard replacing 10% tripe			
Control	—	Water	19.5
			18.0
1% Gelsoy	3	Water	18.5
			19.5

COMMERCIAL PLANT TRIALS

The efficiency of Gelsoy as a binder was determined further in commercial operations. In the first test, a

TABLE 6

Effect of Gelsoy on fat and water separation in potted meat—influence of sodium hexametaphosphate

(Cans were air-cooled)

	Additional water	Fat and water separation
	%	*ml.*
Control	—	21.0
		19.5
0.1% sodium hexametaphosphate	3	19.5
		19.5
0.4% wheat starch dextrine	3	17.5
		17.5
0.5% Gelsoy	3	16.0
		16.0
1.0% Gelsoy	3	15.0
		15.0
3.0% Gelsoy	3	12.0
		9.0
1.0% Gelsoy-phosphate-dextrine	3	17.0
		15.0

Polish sausage formula was employed. Three to 4 batches of sausage were prepared per week, over a period of 3 weeks; thus taking into account the variability of raw materials which is always a factor in sausage-making operations. Using the following formulas, each run consisted of a control and a batch containing the Gelsoy-phosphate-dextrine mixture described above. Observations were made after the sausage had been cooled and stored overnight or longer.

Ingredients	Control	With Gelsoy
	(lbs.)	*(lbs.)*
Beef lean	15	15
Pork lean	40	40
Pork trimmings	35	35
Cheeks	10	10
Nonfat dry milk solids	6	—
Gelsoy-phosphate-dextrine	—	3
Ice	20	20
Cure (includes seasonings)	3	3
Total	129	126

Significantly, the average yield for the control was 108 pounds, whereas the yield for the Gelsoy runs was 118 pounds, indicating a substantial increase in yield. Thus in Polish sausage the water-binding capacity of 3 pounds of Gelsoy or of the Gelsoy-phosphate-dextrine combination was equivalent to or greater than 6 pounds of nonfat dry milk solids.

Another series of tests was made on frankfurters using beef only, that is, with no addition of beef other than that contained in the beef muscle. No pork fat nor pork products were used. Again batches were made daily over a period of 3 weeks. The following formulas were employed:

Ingredients	Control	With Gelsoy
	(lbs.)	*(lbs.)*
Beef	75	75
Nonfat dry milk solids	6	—
Gelsoy-phosphate-dextrine	—	3
Ice	25	25
Cure (includes seasonings)	3	3
Total	109	106

Observations at all points in the frankfurter preparation showed no significant difference in the two runs. Quality of the sausage was comparable and there were

no differences in water or observable fat pockets. The yield for the Gelsoy runs averaged about 5% higher than that for the control. The data again indicated that 3 pounds of the Gelsoy-phosphate-dextrine combination acts as efficiently as a binder as 6 pounds of dry milk solids.

These studies with Gelsoy indicate a possible field of usefulness in manufacturing such meat products as frankfurters, canned meat, and possibly meat loaves *(10, 11)*.

CONFECTIONS

Gelsoy in frozen confections. The composition of ice cream has been well established by Federal regulations, as well as by local governments and by custom. On a liquid basis it generally consists of about 10 to 12% butterfat, 16 to 18% sugars, and about 36% total solids. Variations of this basic formula within the limits of the regulations are well known and literature is replete with work performed along these lines.

Ice cream is most always sold in hardened form; that is, after the liquid mix has been frozen the product is further reduced in temperature to about —20° F., and raised again to about 0° F. at which temperature it is dispensed. In recent years, there has been an effort made to sell ice cream as it comes from the freezer. This has a temperature of about 23° F. and is known as "soft ice cream." The problems confronting the ice cream manufacturer serving either hardened ice cream or soft ice cream are related to the development and stabilization of fine crystals.

In the last 10 years a series of new products resembling ice cream in appearance, but definitely not conforming to the limits set up by Federal regulations, has appeared on the market and met with very good success. These products generally have a low butterfat content of about 3 to 5% on a liquid basis. Frequently the fat is all of vegetable origin. Total solids content is somewhat lower than in ice cream. These products, which in this paper will be termed frozen confections, are dispensed at a temperature of about 20° F. at which point they have a character similar to soft ice cream. Frozen confections have their basis in long known compositions, such as frozen custard, which are generally starchy products. The current frozen confections generally do not contain starch but if they do, the quantity is likely to be less than 0.5% and its function is that of a stabilizer.

The popularity of frozen confections was accomplished through the development of special machines for freezing and dispensing directly to the customer. Again this principle was not new, but was borrowed from the older ice-cream practice. However, there is one important difference, which is that ice cream has a high overrun, generally 90 to 100%. Frozen confections, on the other hand, have an overrun of about 30%. Overrun is an expression for the increase in volume acquired by the liquid mix as it is whipped while being frozen—the increase being due to incorporation of air.

Both ice cream and frozen confections have been made from liquid premixes, pasteurized, and homogenized at a local dairy plant. The dispenser of ice cream or frozen confection generally purchases his product as a liquid premix, adds flavor and color, and does the freezing at his own establishment. Some success has been attained in reducing liquid premixes to dry powders in which case the operators reconstitute the powder and freeze the resulting liquid. With the development of the frozen confection business and the consequent operation of dispensing units far from local dairy establishments, and because of the vagaries of local weather which raise or lower the sale of frozen confections, the desirability of a dry mix powder for this use is apparent.

Such a powder must be properly mixed while all ingredients are still in a liquid suspension, then pasteurized, homogenized, and the stability so fortified that upon reconstitution no separation will occur prior to freezing. All of the other characteristics of desirable frozen confections must also be present such as proper texture, flavor, and overrun.

Nonfat dry milk solids in suspension in a sugar solution with vegetable gums as stabilizer, will give a frozen product with proper overrun but which will be grainy in character. The introduction of fat interposes several other problems of separation and lowering of overrun. The properties of Gelsoy offered a new method for attempting to solve these problems and experiments were performed to develop a formula which would incorporate in a dry premix powder all of the desirable characteristics of a frozen confection.

After considerable effort in establishing the ratio of Gelsoy to nonfat dry milk solids, sucrose, corn sugar, and vegetable fat, along with vegetable gum stabilizers, a basic formula, A in Table 7, was developed.

The materials given in Table 7 were mixed together in liquid form with liquid skim milk as a source of the nonfat milk solids, and pasteurized for 30 minutes at 160° F. The mixture was homogenized at 2,500 pounds pressure and spray-dried. This powder was used in a series of experiments in typical frozen-confection freezing equipment.

For these tests, 1,356 g. of the powdered material was added to 3,800 g. of water and mixed mechanically with a small agitator at a speed of about 1,700 r.p.m. Seven milliliters of liquid vanilla was added for flavoring. The resulting liquid was smooth and remained thoroughly suspended during the period of operations.

The amount of liquid obtained from the mixture was 1.3 gallons. Approximately 3 quarts of this mix was placed in the machine and freezing accomplished in a

TABLE 7

Basic dry mix confection formula

	Formula A	Formula B
	%	%
Sucrose	41.0	39.5
Milk solids, not fat	31.0	29.7
Cottonseed oil	13.1	12.0
Dextrose	12.0	11.5
Gelsoy	1.8	1.7
Sodium chloride	0.5	0.5
Guar gum	.4	.4
Lecithin	.2	.2
Starch, modified tapioca	.0	4.5
	100.0	100.0

normal length of time which brought the temperature down to 20° F. Texture and flavor were comparable or superior to those obtained from currently used liquid premixes.

Effect of starch. The dry formula A shown in Table 7 was somewhat hygroscopic. Drawing upon the experience with frozen custard, which generally contains starch and which is cooked during pasteurization, a modified tapioca starch was added to the basic dry mix as indicated in formula B, Table 7, to reduce hygroscopicity.

The modified tapioca starch was the type normally used in instant puddings and is best described as being cold-water swelling. Combining the starch with the dry mix was accomplished by a blending operation.

The procedure was to mix 1,130 g. of the material as given in formula B, Table 7, with 3,800 g. of water; the resulting volume was 1.12 gallons. Freezing was accomplished as described above. Texture and flavor of this product were superior to those of the product made from the basic dry premix formula A. Repetitive tests showed the product made with tapioca starch to have a constant overrun of about 30% and a smooth texture. In practice it would be best to pasteurize all of the materials prior to homogenization. With this step accomplished and if due care is exercised upon rehydrating the dry premix, there should be little cause for danger of bacterial infection from pathogenic organisms.

Home-type frozen confections. From time to time frozen confections prepared in the home refrigerator have been popular. Generally these products are much coarser in texture than those produced commercially, and their popularity has diminished because of this. The reason is mechanical. The commercial product is frozen while being agitated whereas the home-type product is whipped, then partially frozen, whipped again, and then frozen completely. The composition of the mix has some bearing on the texture of the finished product. Inasmuch as the basic dry mix powder as given in formula B, Table 7, proved successful in commercial operations, this material was then tried in a home type product. For this purpose the amount of starch was increased by 0.5% and the other ingredients reduced accordingly.

The procedure was to place 89 g. of the formula in a mixing bowl with 227 ml. of water and 5 ml. of vanilla extract. The mixture was whipped with a kitchen-type egg beater until thoroughly blended. After partial freezing for 20 minutes in a home-type refrigerator tray, the product was removed and whipped again. It was returned once more to the refrigerator and permitted to stand for 30 minutes.

The product was quite smooth, tasteful, and of good body and texture. Repetitive tests produced the same results, indicating that the basic dry premix given in Table 7, incorporating a whipping protein, produces frozen confections with a variety of practical uses.

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Incorporation of Natural Fruit Flavors Into Fruit Juice Powders.[a] I. Locking of Citrus Oils in Sucrose and Dextrose

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As a phase in a broad program for the preparation of full-flavored fruit juice powders, studies were undertaken to develop methods for returning the volatile fruit flavor separated from the juice during dehydration. With citrus fruits the recovery and the concentration of essence are unnecessary, since high-quality cold-pressed oils have been found to be satisfactory flavoring agents. The oils can be sealed or "locked" in a solid carrier, which prevents oxidation and volatilization. Locking is accomplished by emulsifying the flavoring oil in the molten carrier and cooling the mixture to obtain a dispersion of oil globules within the resulting solid. In recent experiments on locking orange oil, dextrose and sucrose have shown promise as carriers. Corn sirup solids are included as a minor constituent to inhibit crystallization and concurrent formation of small cracks. The flavor imparted to reconstituted orange juice powder by the resultant products is very good. A small-scale storage experiment indicated excellent stability during 6 months at 100° F. (38° C.).

One of the research projects at the Western Utilization Research Branch is aimed at development of natural fruit juice powders by evaporation of water from the juice. The work described in this series of reports is concerned with methods for providing fruit juice powders with full natural flavor. An important part of the flavoring material of fruits is volatile and therefore is separated from the juice during evaporation of the water. This instability leads to two specific problems: first, how to recover the volatile flavor component, or essence *(1, 7)*, and reduce it to a nonaqueous concentrate, and second, how to seal this concentrate in an edible solid carrier which will protect it from oxidation and volatilization and provide a means of rapidly dispersing the flavoring material when the fruit-juice powder is mixed with water. The solid carrier with its sealed, or locked, flavoring material is usually added to the fruit juice powder at the time of packaging.

With citrus fruits, the recovery and concentration of essence is unnecessary, inasmuch as high-quality cold-pressed oils have been found to be satisfactory flavoring agents *(11)*. These oils can be sealed directly in solid carriers *(12)*.

A number of substances, including gelatin *(10)*, vegetable gums *(14)*, and sorbitol *(3)*, have been used or proposed for locking essential oils and flavors. The properties required in an ideal carrier include edibility, rapid solubility in water, insolubility in oil, and ability to solidify in a continuous and stable form without cracks or fissures. In earlier work with fruit flavors, we used sorbitol as the carrier *(3, 12)*. It was satisfactory in many respects, but its usefulness appeared to be limited to the metastable crystalline form. Sorbitol showed a tendency to change from this state to the stable crystalline form, with development of minute cracks. The cracks permitted access of oxygen to the flavoring oil, which led to serious off-flavors. Also, under this condition, the oil was subject to loss by volatilization.

In our more recent work, we have used dextrose and sucrose as carriers and these exploratory experiments have been quite promising. Sugars would appear suitable because of their physical properties and the fact that they are natural constituents of fruit. The products are granular, about 10 to 20 mesh. The flavoring oil is present as minute globules distributed throughout the interior of the grains.

This paper describes the experimental application of dextrose and sucrose to the production of locked orange oil for incorporation with orange juice powder. The procedures developed for locking orange oil appear to be equally applicable to lemon and other citrus oils. Methods for preparing and locking concentrated essence of Concord grapes and other fruits will be presented in following papers.

PREPARATION METHODS

The procedures developed for locking orange oil in dextrose and sucrose are similar in some respects but differ, since anhydrous dextrose can be melted without decomposition while sucrose requires the addition of a small amount of water. The examples given below illustrate in general the best procedures used up to this time. The second of these will be recognized as an adaptation of a well-known method for making hard candy.

Orange oil in dextrose. Four hundred grams of anhydrous dextrose was heated in a one-liter stainless-steel beaker in an oil bath. When the dextrose became mushy so that it could be stirred to prevent scorching, the beaker was placed directly over a gas stove burner, and a motor-driven stirrer was started. After reaching 315° F. (157° C.), which is about ten degrees C. above the melting point of anhydrous dextrose, 100 g. of corn sirup solids (dextrose equivalent = 42%) was added. When the mixture became homogeneous and reached 315° F. again, the gas burner was removed, the inside of the beaker above the liquid level was wiped with a damp cloth, and the melt was allowed to cool to 248° F. (120° C.). The speed of the stirrer was increased, and 40 ml. of cold-pressed orange oil was added dropwise in the vortex over a period of 5 minutes. Stirring was

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continued about a half minute, while a spatula was used to direct the whirling mass toward the center. The emulsion was then poured on a stainless-steel sheet and placed in a low-humidity room, maintained at about 5% RH, where it was allowed to cool and harden. After standing 2 hours, the product was broken up. It was ground with a small coffee-type mill and screened in such a manner as to yield as much as possible in a 10- to 20-mesh fraction. This fraction was placed in a flat dish in a vacuum desiccator and evacuated to a pressure of about 0.01 mm. overnight, with the pump running continuously, to remove oil from the surface of the granules. Finally, the product was placed in a tightly covered jar with a small bag of desiccant *(4, 13)*. The moisture content *(6)* at this time was 0.8%, and the volatile oil content, by steam distillation *(2)*, was 3.2% v/w. Thus, 2.0 g. of this locked flavor was sufficient to flavor one liter of reconstituted orange juice powder on a 0.006% v/w added-oil [6] basis.

Orange oil in sucrose. Four hundred grams of sucrose, 200 g. of corn sirup (55% dextrose equivalent), and 100 g. of water were mixed in a one-liter stainless-steel beaker and heated to boiling over a gas stove burner. Water was boiled off until the temperature reached 302° F. (150° C.). After the mixture had cooled to 248° F. (120° C.), about 32 ml. of cold-pressed orange oil was added. This addition and the remainder of the procedure were as described in the example above. The moisture content was 2.8% and the volatile oil content was 2.4% v/w.

Efficiency. The procedures described are admittedly low in efficiency because of losses from volatilization, which occurs during emulsification and evacuation to remove surface oil exposed by grinding. Moreover, the fines (smaller than 20 mesh) are inferior because of a considerably greater proportion of surface oil. The mechanical loss as fines is approximately 25%. Flavor potency of the product is not as high as desired, but it can undoubtedly be improved. Volatile oil contents up to 4.0% v/w have been obtained in preparations similar to the second illustration but with quantities one-fourth as large. We are at present investigating means for continuous emulsification in a closed system. Such a method should minimize the time during which the flavoring oil is hot, greatly reduce losses, and yield products with higher flavor potency.

Prevention of Crystallization

Our first preparations of orange oil locked in dextrose were made without addition of corn sirup solids. The emulsification step was carried out at 230° F. (110° C.). After the emulsion cooled, the dextrose hardened to a glassy, amorphous solid. When the product was kept in a closed container, it remained glassy, but when it was exposed to the atmosphere with a relative humidity of about 40%, it first absorbed water and became sticky. On further standing for 2 or 3 days, it lost water and crystallized as anhydrous dextrose, becoming opaque. The temporarily absorbed water can be thought of as a lubricant which allows the dextrose molecules to slide by each other and arrange themselves in the crystal lattice *(5)*.

Experimentation has shown that orange oil is not locked in crystalline dextrose as well as in the amorphous solid (Table 1). Two preparations were made as nearly alike as possible, except that one was kept dry while the other was allowed to crystallize at 65% relative humidity. The original analyses were made after the usual evacuation at room temperature to remove oil from the surface of the granules. A sample of each preparation was then tested by evacuation again, at 0.2 mm. pressure for 21 hours at 113° F. (45° C.), followed by reanalysis for oil content. The amorphous sample retained most of its oil, while the crystalline sample suffered a large loss, perhaps as the result of small cracks formed during crystallization. It is concluded that flavors locked in dextrose should be kept in the amorphous state and that protection from moisture is an important factor in maintaining this condition and in preventing stickiness. The need for protection from moisture is not a serious restriction, for fruit-juice powders must be packaged dry in any event.

As further means for prevention of crystallization, we investigated the use of other sugars and related compounds with dextrose (Table 2). Crystallization was observed by use of a polarizing microscope. Of the substances tried, corn sirup solids proved to be the most effective crystallization inhibitor. Corn sirup serves the same purpose with preparations in which sucrose is the main ingredient.

TABLE 1

Retention of oil by orange oil-dextrose preparations when evacuated at 113° F. (45° C.)

State of dextrose	Volatile oil content, % v/w	
	Original	After evacuation [1]
Amorphous	4.1	3.9
Crystalline	3.8	1.4

[1] Evacuated 21 hours at 0.2 mm. of mercury.

Effect of additives on viscosity. Molten anhydrous dextrose can be supercooled only to about 230° F. (110° C.) without becoming too viscous for emulsification with flavoring oils. It is desirable to have a lower viscosity, so that the melt could be cooled to a lower temperature before adding the oil, but unfortunately corn sirup solids and other good inhibitors of dextrose crystallization increase the viscosity of molten dextrose at 230° F. (110° C.) (Table 2). However, a proportion of corn sirup solids considerably smaller than that indicated in Table 2 (33%) would probably be adequate for preventing significant crystallization under practical conditions, even if the product were exposed to ordinary humidity for several days.

TABLE 2

Effect of other substances on crystallization of dextrose at room temperature and about 40% relative humidity and on viscosity of the melt

Proportion of added substance	Time required to develop 0.1 mm. crystals	Viscosity at 230° F. (110° C.)
	Days	*Arbitrary Units* [1]
None	2	5.0
33% Corn sirup solids [2]	48	7.6
33% Sucrose	35	8.0
33% Lactose	~35	7.7
33% Methyl glucoside	~20	3.9
33% Sorbitol	6	2.7
16% Propylene glycol	1	2.8
~3% Water	1	4.0

[1] Rheostat setting to give rate of stirrer rotation equal to 300 r.p.m.
[2] Dextrose equivalent = 42%.

A small proportion of water can be used to lower the viscosity. Dextrose containing 3% water can be cooled to about 200° F. (93° C.) without becoming too viscous. Although water promotes crystallization, such products have remained amorphous up to at least 6 weeks at room temperature, when placed in a desiccator immediately after preparation, even though no crystallization inhibitor was present. However, when one of these products (a few days after preparation) was evacuated at a pressure of 0.15 mm. for 21 hrs. at 113° F. (45° C.), the granules fused together and the volatile oil content decreased from 4.3 to 3.1% v/w. Further experiments are necessary to determine the proportions of corn sirup solids and water that will result in the lowest viscosity consistent with adequate stability of finished product.

When sucrose is the principal constituent of the carrier, the proportion of water can be changed by variation of the temperature to which the original mix is boiled.

[6] The volatile oil that may be present in orange-juice powder at the conclusion of dehydration has negligible flavor value *(9)*.

PRODUCT QUALITY

Flavor quality. The flavor imparted to reconstituted orange juice powder by orange oil locked in dextrose or in sucrose is very good and is comparable to similar preparations made with sorbitol. Samples of the products described under "Preparation Methods" were each compared with orange oil locked in sorbitol in separate triangle tests by a taste panel of experienced judges. In the comparison of dextrose with sorbitol there were 34 correct selections out of 86 judgments and in the comparison of sucrose with sorbitol there were 11 correct selections out of 36 judgments. Thus, no significant difference in flavor was detected. It is evident that no appreciable heat damage was suffered by the flavoring constituents at the relatively high emulsification temperatures used with dextrose and sucrose.

A similar comparison of lemon oil locked in sucrose with the same oil in sorbitol showed no significant difference in flavor (13 correct selections out of 40 judgments).

Stability in storage. A small-scale storage experiment was made with samples of orange oil locked in dextrose (100%), sucrose (with corn sirup), and sorbitol. The samples were air-packed in 6-oz. cans with a 10-g. bag of calcined lime as desiccant in each. The locked flavors were packed both alone and with orange powder. In the former case, the amount in each can was 5 times the amount required to flavor one can of orange powder. After conditioning *(8)* two months at 77° F. (25° C.), the samples were stored at 100° F. (38° C.) for 6 months. Initial and final volatile oil contents are shown in Table 3. There was no significant loss of oil with any of the samples, including those which were evacuated at a pressure of 0.01 mm. for 48 hours at room temperature after the storage period.

TABLE 3

Stability of locked orange oil preparations during storage for six months at 100° F. (38° C.)

Storage condition	Carrier					
	Dextrose		Sucrose[1]		Sorbitol	
	Oil content	Av. flavor score	Oil content	Av. flavor score	Oil content	Av. flavor score
	% v/w		% v/w		% v/w	
Initial, before storage	4.13	7.0[3]	2.30	6.7[3]	4.68	6.1[3]
Stored alone, reevacuated[2]	4.29	6.6	2.16	7.0	4.41	6.3
Stored with orange powder	4.18	—	2.17	—	4.32	—

[1] 72% sucrose and 28% corn sirup solids.

[2] The portion for volatile oil analysis was evacuated at 0.01 mm. for 48 hrs. at room temperature after storage. The portion for tasting was not reevacuated.

[3] Score for the locked flavor stored at —30° F. (—34° C.).

The flavor of these samples was evaluated by a panel of 6 trained judges, with scoring on a numerical basis. Portions of the locked flavors stored alone were prepared for tasting by addition to reconstituted orange juice powder which had been kept under refrigeration. In each case the concentration of added oil was 0.01% v/w. The samples were tasted in 4 groups of 2 or 3 samples each. There were no meaningful differences in the scores of the stored flavors locked in dextrose, sucrose, and sorbitol (Table 3). Neither was there any meaningful difference between the scores of any of the locked flavors stored 6 months at 100° F. (38° C.) and the corresponding sample stored at —30° F. (—34° C.). Although the results are not conclusive, due to limited scope and small number of flavor judgments, these organoleptic and analytical data indicate very good stability and retention of orange oil in both sorbitol and the sugar carriers.

SUMMARY

Locked orange oil in granular form, suitable for flavoring orange-juice powder, has been prepared by emulsifying orange oil in molten dextrose or sucrose and cooling, grinding, and evacuation of the product. A minor proportion of corn sirup solids is included to inhibit crystallization. Crystallization results in the formation of small cracks, thus "unlocking" the oil. For complete prevention of crystallization, these locked flavors should be kept relatively dry.

The flavor imparted to reconstituted orange juice powder by these new products is very good, both initially and after storage of the flavors for 6 months at 100° F. (38° C.).

Means for improving efficiency of the locking process are now under investigation.

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Notes and Letters

The Broth-Like Flavor of Methional

The significance of methional, 3-methylmercaptopropionaldehyde, in the sunlight flavor defect of milk has been reported *(2)*. The broth-like flavor qualities of the compound are impressive and perhaps may be of importance beyond the field of milk products. The flavor and aroma of cooked meats, soups and boiled vegetables frequently suggest the presence of methional. The rather widespread distribution of methionine in food stuffs, and the plausibility of its conversion to methional by the Strecker degradation *(4)* during the cooking process lend supporting evidence to the occurrence of methional in certain foods. Another instance in which the odor of methional is strongly manifest is the various peptone and meat infusion media used for bacteriological purposes. Regarding potency, methional is detectable in milk at a level of 0.05 p.p.m. The addition of as little as 4 mg. of methionine per quart of milk greatly intensifies the methional flavor produced in such milk upon exposure to sunlight.

Methional has been prepared at this laboratory in good yield (74%) from acrolein and methyl mercaptan by the method of Pierson *et al. (3)*. The pure compound has an overpowering disagreeable odor which quickly permeates the room. The following constants for the compound have been observed: b.p. 71 to 73° C. at 23 mm., n_D^{20} 1.484 and D_4^{20} 1.040. The 2,4-dinitrophenylhydrazone has been prepared and observed to melt at 120.5° C. This derivative readily regenerates methional when warmed in levulinic acid. In the paper chromatographic technique for separating 2,4-dinitrophenylhydrazones by Heulin *(1)*, the methional derivative moves slightly slower than that of acetaldehyde and somewhat faster than that of formaldehyde.

Stuart Patton
Department of Dairy Science
The Pennsylvania State University
University Park, Pennsylvania

November 4, 1955.

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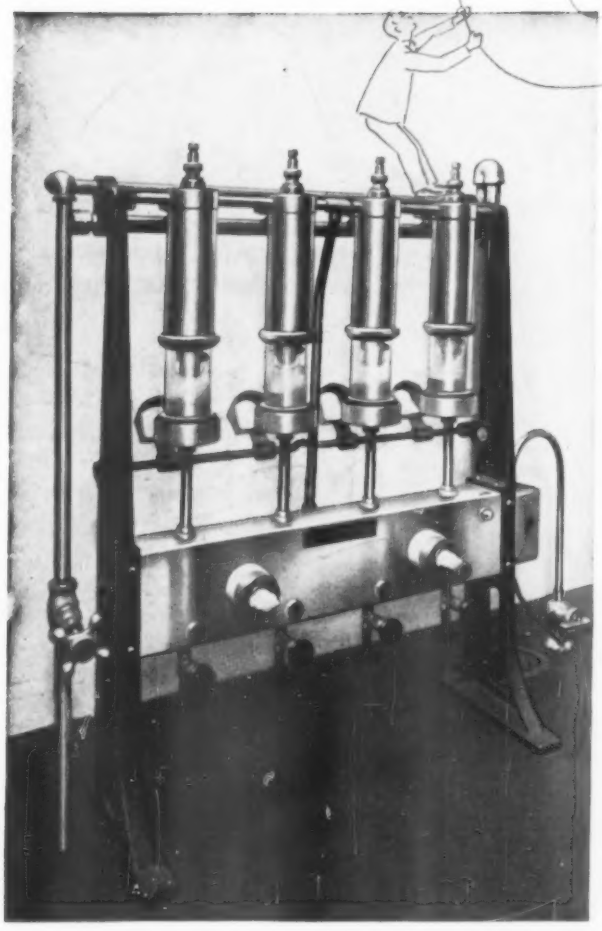

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. . . in the public interest

Food from U. S. land resources should be ample for an estimated 222 million by 1980, believes Mr. Floyd J. Hosking, executive vice president of Corn Industries Research Foundation, Inc., New York City, who recently addressed the Agricultural Research Institute. He based his estimate on the probability of a continuing upward trend in grain and animal production through vastly improved techniques of farming and animal feeding. Assuming such advances, he is convinced that annual harvests approaching 4 billion bushels of corn are distinctly probable before 1980. Total corn acres have declined from 111 million in 1917 to a little over 80 million in 1955, yet the annual corn harvest has increased to over 3 billion bushels. If the nation's corn crop averaged 50 bushels an acre (current national average is nearly 40 per acre), 4 billion bushels would be grown on the present total corn acreage, he pointed out.

◆ ◆ ◆

How can industrial management know that the firm's technical operation is performing to maximum effectiveness? At a recent panel discussion dealing with this subject, held at MIT, 5 members of Arthur D. Little, Inc., 30 Memorial Dr., Cambridge, Mass., consulting research firm, discussed an objective evaluation activity. Dr. Warren C. Lothrop, vice president explained that the ADL teams which make "technical audits" investigate the principles underlying a company's whole technical program. The teams are not concerned with efficiency studies, personality evaluations, or psychological testing, but rather with advising management on its assets and means for achieving greater results in their use. Dr. Lawrence W. Bass, ADL vice president, dealt with management's relationship with the technical departments. He stressed the importance of recognizing the research and development executive as a member of management so that he can crystallize company thinking on areas of growth for which scientific and engineering information will be sought. Dr. C. Richard Morgan concerned himself with administrative aspects of a research and development department. He pointed out that the internal organization of this group is less important than is the group's place in the total company framework, and stressed the importance of communication between this department and Management, Production, and Sales. Dr. Austin W. Fisher, Jr., discussed the problems of communication and project transition between the research development and engineering groups, and with both sales and production departments. His point was that such communication must be in 2 directions so that, first, the original programs are selected properly, and that secondly, the results of research are translated effectively into action. Mr. Richard S. Robinson traced the evolution of 2 other functions derived from the research and development activities. First to appear was that of technical service, which deals directly with customer needs. From this has come a second—market research—that of investigating commercial development possibilities for new products. By keeping these functions distinct and feeding them into the programs more effectively, he stated, both the research and sales groups can function more effectively.

◆ ◆ ◆

Manufacturers and merchants, like automobile makers, are learning it pays off in sales to capitalize on the public's desire for change. This new concept of packaging, calling for a program of continuous redesigning of packages, promises future expenditures which will dwarf the current figure of $11 billion a year spent on packaging, according to Mr. George W. McCleary, sales promotion manager of Olin Film Division of Olin Mathieson Chemical Corp., 460 Park Ave., New York 22, N. Y. The packaging expert described the new idea as "concentration on repackaging rather than packaging." He believes both cellophane and polyethylene film will account for a continuously increasing share of the growing packaging business, pointing out that sales of polyethylene advanced from 45 million pounds in 1953 to 70 million pounds in 1954, and that experts predict this figure will reach 120 million pounds for 1955. He also noted that cellophane was being used for an ever-increasing number of end uses; that it was finding a growing market in soft goods, indicating increased cellophane business.

◆ ◆ ◆

Opposition to a proposal to further reduce import duties on confectionery products was voiced recently by the National Confectioners' Assn., 221 N. LaSalle St., Chicago 1, Ill., through Mr. Harry R. Chapman, Association vice president. Appearing before the U. S. Tariff Commission and the Committee for

(Continued on page 32)

New possibilities for continuous processing!

...with Foxboro sanitary proportional flow control

Foxboro Magnetic Flow Meter . . . transmits flow measurement to recorders or controllers.

You no longer have to discard new ideas in continuous process design for want of adequate flow control! Foxboro now provides the first complete sanitary proportional flow control system ever available.

Heart of this system is the Foxboro Magnetic Flow Meter. It has proved highly successful in measurement of widely varied food products including beer, tomato products, apple juice, and grape juice. And it's equally applicable to many others, such as egg yolks, wine—even molasses! It measures *magnetically*, with no flow interference, no pockets, crevices, or projections to collect residue or contamination. And its high accuracy is sustained, despite variations in conductivity, density, and viscosity.

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Foxboro Magnetic Flow Meter. Accurately measures the flow of virtually any liquid except non-conductors like chocolate, fats and oils. Installs easily in the line like any equivalent length of pipe. **No** taps, seals, purges, meter runs, or straightening vanes required. Connects by 2-conductor cable to remote Dynalog Controller.

Foxboro Dynalog Recording Controller. Responds instantly to changes in volume flow, initiates fast, accurate valve action to hold pre-set rate. Troublefree, stepless measuring circuit has no slidewire — requires no standardizing or batteries, practically no maintenance. Control action can be air-operated or electric-operated.

Foxboro 2-way Saniflo Control Valve. A streamlined valve for liquids, suspensions, viscous or pulpy materials. Equally effective for throttling (proportional) or open-and-shut control. One-piece stem and plunger — no threads or crevices to harbor bacteria. Quick-disconnect clamp for easy cleaning. Can be replaced in control system by other type valve or a pump to meet process requirements.

FOXBORO
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SANITARY FLOW CONTROL

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

FOOD INDUSTRY TOPICS

(Continued from page 30)

Reciprocity Information, which groups are considering proposals to reduce the duty on a long list of commodities, he stated that no tariff concessions should be granted which will result in injury to a single domestic industry. Mr. Chapman pointed out how the former import duty of 40% on sugar and chocolate confectionery products already has been reduced to 14% and 10% ad valorem, respectively. By statistical tabulations, he showed how the reductions had been followed by substantial increases in quantity of imports. He urged that the import duty on confectionery actually be increased because of tremendous difference in cost of production in various foreign countries and the U. S., due principally to cost of ingredients and labor. "Our country is in the inconsistent position," he stated, "of promoting a protectionist philosophy for one segment of our economy, namely agriculture, and a free trade philosophy for manufactured goods." A further reason why confectionery duties should not be further reduced, according to Mr. Chapman, is that American confectionery manufacturers, in attempting to export their own products, "have found that the attitude of most foreign governments towards our products is that free trade is a one-way street."

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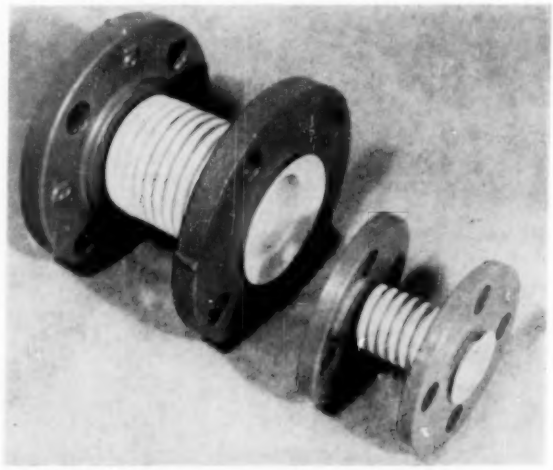
Scientists at Rutgers College of Agriculture, New Brunswick, N. J., studying the effects of trace minerals on the nutritional value of foods, have turned up an experimental "animal" that is saving thousands of dollars and working hours in the course of the 5-year basic research project. The confused flour beetle, a diminutive creature not much larger than the head of a pin when full grown, is the hero of this scientific saga. Little "Tribolium Confusum" is playing the role generally reserved for the rat, a relatively huge and much less obliging fellow. The economy, money-wise and time-wise, in using this insect instead of rats or mice or dogs is shown by statistics. To achieve with rats the same data supplied by 270 flour beetles—housed in a glass container covering roughly one square foot of shelf space—the scientists would need 90 cages full. One pound of food suffices the entire group of beetles during tests that run approximately 25 days. Ninety rats in that time would literally eat the scientists out of house and home. Rats, moreover, have to be fed, watered, and cleaned every 2 or 3 days, whereas the Rutgers "beetle keeper" spends less than an hour a day with his charges—merely observing them. Drs. M. Wight Taylor and Alfred N. Meiss are in charge of the project.

◆ ◆ ◆

Industry is turning more and more to use of vending machines to feed employees, according to a nation-wide survey of 5,000 industrial plants made by the Field Research Division of the Paper Cup and Container Institute, Inc., 270 Park Ave., New York 17, N. Y. Of the 1,200 plants that answered the survey questionnaire, about 55% are offering some food service, and 84% of the plants that do any feeding use some vending machines. Almost 40% of plants using machines said they introduced them within the past 5 years. Plant management gave a variety of reasons for feeding their employees. More than half, 310 out of 618 replying, said they offered food service as a matter of "company policy." Almost as many, 307, said food was made available because there were no nearby facilities. Only 6 plants said that union contracts required food service. Moreover, plants now offering food service invariably intend to expand their operations in this field. A full report, also covering such facts as location of vending machines and types of foods currently vended, is available without cost from the Institute.

. . . *things new under the sun*



Two new products made from chemically inert fluorocarbon resins are offered by Resistoflex Corp., 39 Plansoen St., Belleville, N. J. The items are (1) Fluoroflex-T Pipe Elbow—a T pipe elbow of short radius construction, available in both 45° and 90° types, and designed for use with Fluoroflex-T laminated pipe or any ASA flanged piping; (2) Fluoroflex-T1001 Molded Bellows (illustrated). Bellows and expansion joint is chemically inert and may be obtained in 1", 1½", 2", and 3" diameters. Custom fabricated designs and shapes also may be ordered. The products are recommended for applications involving acids and caustics, foods and drugs, hot lacquers, steam, synthetic oils, jet fuels, and gases and vapors under extreme conditions of temperature.

◆ ◆ ◆

Takamine Laboratory, Inc., Clifton, N. J., has introduced its **glucose oxidase-catalase enzyme system, DeeO,** to canners of carbonated soft drinks. The enzyme is a catalyst which promotes the reaction between oxygen and glucose and, consequently, is able to remove oxygen from products when glucose is present. DeeO effectively reduces can corrosion, iron pick-up,

(Continued on page 34)

A

Proctor

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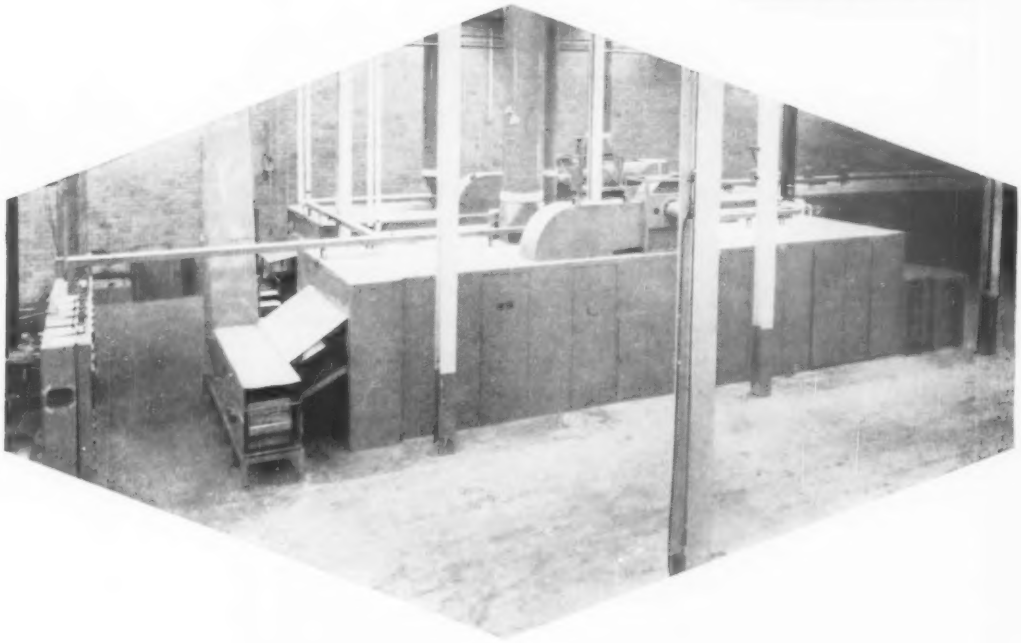

Efficient drying per pound of product can often *mean more direct profit to you* than an increased sales volume! Proctor equipment provides the control, flexibility, and construction features *essential* to profitable drying performance. The result—increased yield of highest quality product. Write or phone *today* for complete information.

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FOOD INDUSTRY TOPICS

(Continued from page 32)

and protects flavor and color of drinks containing azo-type food grade dyes. Available in tonnage quantities, it is easy to use, and does not have to be handled with extreme care. The dry powder is storage stable indefinitely if kept in a dry, cool place.

◆ ◆ ◆

A recent report by the Food and Drug Administration gives final approval for use of NDGA Antioxidant for preventing rancidity and off-flavors in foods susceptible to oxidative deterioration. NDGA Antioxidant (Nordihydroguaiaretic Acid—a natural antioxidant extracted from an Evergreen desert shrub) was the first effective food grade antioxidant to win such approval. Discovered by the University of Minnesota in 1942, it is produced under an exclusive license from the University by Wm. J. Stange Co., 342 N. Western Ave., Chicago 12, Ill. The product, recognized as the most powerful antioxidant available, is widely used to protect animal and vegetable fats, candies, dairy products, fish, citrus and essential oils, vitamin oils, and many other special products from undesirable oxidative changes.

◆ ◆ ◆

Automation is improving quality and cutting production costs of fresh frozen juice concentrates at Minute Maid's Florida plants, according to Mr. B. M. Middlebrooks, director of concentrate manufacturing for Minute Maid. He described how these improvements result from a **new system of can handling** which requires only one man's attention from the time the empty cans are received until they enter the closing machines. The new system is a joint Minute Maid-American Can Company development. Using a Dudley Can Unscrambler, it eliminates manual placement of cans into a can truck for delivery to the closing machines. The present 6-lane Dudley Unscrambler handles from 900 to 1,100 cans per minute, and reportedly creates substantial savings in processing costs because of uniformity of flow and improved average rates of production at the closing machine. For fuller information write Minute Maid, c/o Burns W. Lee—Patrick O'Rourke, Inc., 608 Fifth Ave., New York 20, N. Y.

◆ ◆ ◆

A test recently developed by Morton Salt Co., 120 S. LaSalle St., Chicago 3, Ill., and approved by the Quality Control Committee of the National Potato Chip Institute enables a chipper to **quickly, simply, and accurately determine the salt content on potato chips.** To assure accurate testing and to take the guesswork out of matching titration colors, a stirring rod has been made which encloses scientifically balanced titration end point colors and is available for use with the test. Testing procedure and color standard stirring rods are available to chippers free of charge from Morton Salt Co.

◆ ◆ ◆

A new, low cost homogenizer, the VirTis "23"—23,000 r.p.m.—offered by E. Machlett & Son, 220 E. 23rd St., New York 10, N. Y., is equally effective for both micro and macro work. It handles volumes from 0.2 to 200 ml. through use of 4 simple-to-attach fluted homogenizing flasks. Fitting snugly atop the flasks is a specially designed aerosol-free assembly, fashioned from Teflon. The assembly prevents harmful aerosols from escaping, and protects the substance being homogenized from outside impurities. Running through a friction-free bearing in the aerosol-free assembly is a precision-ground shaft with 18-8 stainless steel cutting blades. Matchlett says the superior top drive design eliminates heat formation and does away with leakage problems.

◆ ◆ ◆

A new Norelco MG 160-D X-ray unit that covers a wider field and provides either 40° or 120° apertures for rapid inspection of welds, pipe lines, power plants, etc., is announced by Research and Control Instruments Division, North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y. Eccentric positioning, permitting simplified techniques which save time, material, and labor, is possible with cylinders having a minimum diameter of 28½". With smaller diameters, centric positioning is employed. The novel arrangement of tube and generator in one housing eliminates need for high-tension cables. Designed for maximum radiation safety, the improved MG 160-D unit weighs only 143 pounds. The accompanying stepless control weighs 99 pounds. Power supply is 230 volts a.c., and current drain is 10 amperes.

◆ ◆ ◆

The Model III Photoelectric Analyzer, a new instrument for **automatically analyzing, recording, and controlling chemical processes involving liquids, vapors, or gases,** is announced by Manufacturers Engineering and Equipment Corp., Hatboro, Pa. Because of unique self-monitoring properties, it not only records or controls a process, but periodically and automatically checks and resets itself to compensate for any smudge accumulation on cell windows or other similar sources of error. The instrument serves not only as a powerful tool for process control or as an automatic recording analyzer in chemical plants, but equally well in problems involving monitoring and

prevention of stream pollution. In addition to liquid analysis, the Model III will automatically record quantities of gas or vapor in air, down to a few parts per billion, of such substances as mercury, ozone, napthalene, benzaldehyde, nitrobenzene, bromine, sulfur dioxide, xylene, and many others.

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There's less than a tablespoonful of Aureomycin in the container held by Dr. Wilbur Miller, American Cyanamid Company scientist, but it's enough to keep more than a quarter-ton of poultry fresh twice the normal time. Aureomycin, first antibiotic to be accetped by the Federal government for use in food preservation, is the basis for Cyanamid's recently announced Acronize process for poultry. The Aureomycin helps keep food fresh by holding back the growth of spoilage bacteria.

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A complete new line of industrial and commercial water softeners and conditioners, introduced by Culligan, Inc., Northbrook, Ill., features a new, exclusive water collection system that makes possible more efficient softening of water per pound of mineral used. The system consists of finely slotted manifolds spaced 6" apart at bottom of tank. This means that water passes through the entire mineral bed eliminating the chance one downhill channel will be created, thus causing the water to bypass the bulk of the mineral. Elimination of the need for a supporting gravel bed allows more room for the mineral, hence, more capacity per unit. Buyers have a choice of 2 minerals—Cullex or Cullite. Twelve model sizes offer capacity ranges from 255,000 to 2,304,000 grains. Write the firm c/o Harshe-Rotman, Inc., 8 S. Dearborn St., Chicago 3, Ill.

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A radically new design **evaporative-type refrigerant Condenser** in capacities ranging up to 240-ton ammonia refrigeration is announced by Niagara Blower Co., 405 Lexington Ave., New York 17, N. Y. The Aeropass Sectional Condenser features great accessibility, all sections being encased in separately removable panels. Removing a single panel puts all interior parts within reach. Much expense is saved the owner by the design which permits shipment of the casing as flat panels rather than box-like shapes. There are 4 sizes: 90, 120, 180, and 240 tons. The

NIAGARA "NO FROST"

25 Years' Successful Experience

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Always full capacity

★

Never any defrosting shutdown

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Always clean Freezing or Storage Rooms

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Write for Niagara Bulletin 105

Fruit Pre-cooling and Storage

NIAGARA BLOWER COMPANY

Dept. F. T., 405 Lexington Ave., New York 17, N. Y.

District Engineers in Principal Cities of U. S. and Canada

FOOD INDUSTRY TOPICS

ratings are for ammonia, but the Condensers are also applicable to freon. Dimensions of the largest size are, approximately: length 13 feet, width 16 feet, height 10½ feet.

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A new air-powered unit, the End Stapler, is offered by International Staple & Machine Co., 801 Herrin St., Herrin, Ill. The high-speed unit has no electrical connections. It features a new 2-cycle air motor with a completely new mechanical trip, as well as International's patented retractable anvils which allow the carton to close after it is filled. Specially designed for perfect closures of end opening cartons, full overlap, partial overlap, telescope, and many other types of cartons, the End Stapler can be turned to a 90° angle for center slotted cartons and special applications. Weight is 155 pounds. The closures made with the unit meet Rule 41 requirements of General Freight Classifications and Parcel Post Regulations. It will close A, B, and C flute corrugated, and as much as 350 pound double wall cartons. It will handle all standard thicknesses of solid fiberboard cartons.

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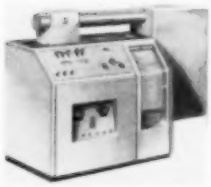

A new Raman Spectrophotometer that has **increased speed, accuracy, and convenience** has been developed by Applied Physics Corp., 362 W. Colorado St., Pasadena, Calif. The Cary Model 81 has improved systems and components which give high light-gathering power, freedom from effects of scattered light, and high zero stability, enabling a complete Raman spectrum of benzene, for example, to be made in 5 minutes on as little as 0.1 ml. of sample, yet retaining good accuracy. The unit covers a wide range of spectral data which normally would require 2 or 3 separate instruments, or at least a change in optical materials several times in a single instrument. Raman spectroscopy is often a good method of determining total concentration of a certain type of compound. Because water and other polar compounds exhibit weak Raman spectra, they are suitable for use as solvents in Raman spectroscopy.

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A new method of clarifying, simultaneously, water containing both settleable and non-settleable particles now is offered by Graver Water Conditioning Co., 216 W. 14th St., New York 11, N. Y. By addition of a surface skimmer to Graver's solids-contact clarifier, the Reactivator (R), the unit now can remove, in one operation, both those particles and precipitates with a natural tendency to settle, and those whose natural buoyancy causes them to surface. It is most effective in treating white waters from pulp and paper mills, and in removing oil from water which also contains settleable particles.

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A new van trailer equipped with air slide unloading to handle bulk flour deliveries is announced by Fruehauf Trailer Co. At present, the van is being loaded by means of gravity through 3 hatches in the top. Eventually this will be superseded by an air-pressure loader which will increase total load of bulk flour from 18 to 22 tons. Increased load is secured by the fact that the trailer itself has been kept at minimum weight through use of stainless steel and aluminum in its structure. The flour is fed into the storage bins of a purchaser by means of an air slide device operated by 2 blowers which delivers the flour to the air hose. Standard discharge equipment consists of 4-inch lines, permitting discharge of flour 100 feet above ground level at the rate of 20 or more tons per hour. Write the firm c/o Schipper Associates, 99 W. Bethune, Detroit 2, Mich.

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Wheelabrator Corp., 1095 S. Byrkit St., Mishawaka, Ind., announces Wheelabrator Ultra-filtration, a process developed for **super cleaning atmospheric air with industrial-type filtration equipment.** The process, which employs conventional industrial Wheelabrator Dustube dust collectors of the tubular cloth filter type, may be used in applications formerly employing disposable or viscous filters, or low-voltage electrostatic precipitators. Advantages claimed are extremely high cleaning efficiency, moderate cost, and nearly complete freedom from maintenance expense. In one installation having a design volume of 720,000 c.f.m. of city air, a collection efficiency against fine atmospheric dust of 99.23% was achieved over a year's period.

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A new line of water softeners for manufacturing plants, institutions, and commercial establishments has been developed by Hagan Corp., 323 Fourth Ave., Pittsburgh 22, Pa., in conjunction with Calgon, Inc., a subsidiary. The softeners are sold as package units, so that only simple connections, requiring a minimum of installation time, are needed to fit a unit into a water system. A supply of Hagan Resin C-300, a high capacity resinous exchange material, is provided with each. Each unit consists of a brine tank and a softener tank, with controls and piping in place. Twin units, which include 2 softener tanks with a single brine tank, also are available. Flow rates can be as high as 175 gallons per minute for a single unit, or

(Continued on page 39)

Institute of Food Technologists

THE PROFESSIONAL SOCIETY OF FOOD TECHNOLOGISTS

The Institute of Food Technologists numbers among its active members leading scientists, technologists and engineers in the field of Food Technology.

The Institute invites your professional association with this select group of scientific and technological workers. Only those who are qualified by education, special training, or experience are extended this invitation.

Food Technology may be defined as the application of science and engineering to the production, processing, packaging, distribution, preparation and utilization of foods. Scientists, technologists and engineers engaged in Food Technology, executives, officials and supervisors under whose jurisdiction Food Technology operations are conducted, research investigators, teachers, and others working in the field of Food Technology, will find membership in the Institute worth many times its modest cost.

If you can meet the qualifications for membership, you owe it to yourself and to your business or profession to become a member.

OBJECTIVES

The Institute is a non-profit, professional, educational association to promote the application of science and engineering to the production, processing, packaging, distribution, preparation, and utilization of foods; it stimulates investigations into technological problems arising therein, it provides a medium for presenting and discussing the results of such investigations; it stimulates and provides means for the free interchange of technological information and ideas among food technologists; it promotes recognition of the role of food technologists in the technical direction of operations in these fields; all of these activities have the ultimate objective of providing better and adequate foods for mankind.

ORGANIZATION AND PROGRESS

Organized July 1, 1939, at Cambridge, Mass., with a membership of less than 100, the Institute has grown to more than 4,000 (1954). It is world-wide in scope, with members in North, Central, and South Americas, the Scandinavian countries, England, Holland, Germany, France, India, Australia, and New Zealand.

MEMBERSHIPS

Professional Members. Any person who is ethically qualified, and who has had training and experience in food technology, or any person who in the opinion of the Council is recognized as distinguished in the contributing sciences as they apply to foods, shall be eligible to be a Professional Member of the Institute. The minimum training which shall qualify a candidate for eligibility for Professional Member is, in general, graduation from a college, university, or similar institution in which he has majored in one or more of the sciences or branches of engineering associated with food technology. The minimum experience shall be three years experience in food technology. The Council may, at its discretion, waive any or all of the foregoing requirements in the case of a person who, thru long experience, has distinguished himself in the field of food technology.

Members. Any ethically qualified person, active in special or limited aspects of food technology, who is an administrator, director or executive under whose jurisdiction operations in food technology are conducted; or who is engaged in the dissemination of knowledge of food technology; or one whose work requires a general knowledge of the broad principles of food technology as it applies to the products, processes or equipment with which he or she is concerned; or one scientifically trained in and who has entered a career in food technology; shall be eligible to become a Member.

Student Members. Any ethically qualified person who has never been a Professional Member or Member of the Institute, who is registered as a student in an educational institution with at least Junior (third year) standing, who is a candidate for a Bachelor's or higher degree in one or more of the sciences or branches of engineering associated with food technology, shall be eligible for membership as a Student Member. This classification shall be his status only until the end of the calendar year in which he completes his schooling. When graduated and otherwise qualified as defined in the section on "Members," a Student Member may, upon application, be elected to Membership.

DUES

Professional Members and Members—$7.50 per year; Students—$2.50 per year. Dues include a subscription to Food Technology.

PUBLICATIONS

Food Technology, issued monthly, is the official journal of the Institute. It is published to advance the profession of food technology by disseminating the results of research and their practical application in industry. Contributors to its pages represent many fields of scientific and technological interest.

Food Research, published bi-monthly, is devoted to publication of the results of original investigations and occasional reviews in the fields of food and beverage technology, chemistry, and microbiology. Food Research is available to Institute members at the special rate of $7.50 per year.

REGIONAL SECTIONS

Where sufficient members (25 or more) live within commuting distance of a given point, a Regional Section may be established. Such Sections are able to hold meetings at more frequent intervals than the National group, thus affording the food technologists regular opportunities for an exchange of views and ideas with others in the area. There are presently 24 Regional Sections.

ANNUAL MEETINGS

Each year one of the regional sections acts as host to the Institute at an annual meeting. The program of this annual conference is designed to acquaint members with various phases of food production, processing and distribution, and to keep them abreast of current trends and technological developments. The speakers invited are those whose subjects will build a well-rounded program, of interest to the greatest number. Annual conferences are highlighted by exhibits of new equipment, processes and special ingredients.

AWARDS

The society administers the following awards:

NICHOLAS APPERT AWARD (Medal). Each year the Chicago Section of the Institute makes this award to a person whose contributions to the food industry make him distinguished and outstanding in the opinion of the national jury.

BABCOCK-HART AWARD ($1,000.00). The purpose of this award, made by the Nutrition Foundation, is to encourage contributions to Food Technology which will have an influence on the nutritional well-being of the general population.

FLORASYNTH FELLOWSHIP AWARD. $1,000 granted annually to a young man or woman under 35 years of age, engaged in senior undergraduate or graduate work, as a candidate for an advanced degree, in recognized educational institutions in the United States or Canada, which is conducting fundamental investigations for the advancement of Food Technology.

GENERAL FOODS FELLOWSHIP AWARDS. Three Fellowships will be granted annually—no more than two to the same educational institution for the same calendar year, but will be renewable upon application to and approval by the Awards Committee of the Institute for a maximum of three years, in order to provide for continuity of studies leading to a doctorate degree, if the candidate so plans. However, candidates, who plan only a year of research after obtaining the Bachelor Degree, or who plan to read for a Master's Degree, will not be excluded from these fellowship grants. Each Fellowship is worth approximately $4,000.

GERBER BABY FOODS POST-DOCTORATE FELLOWSHIP AWARD. This Fellowship to promote research in some newer phase of food technology is worth $6,000.00 per annum and may be renewed for an additional year.

JOHN S. COLEMAN

Portrait by Fabian Bachrach

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JOHN S. COLEMAN, ***President***
Burroughs Corporation

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THE INSTITUTE OF FOOD TECHNOLOGISTS

FOOD INDUSTRY TOPICS

(Continued from page 36)

350 for a twin, with capacities between regenerations ranging up to 1,500,000 grains for a single unit and 3,000,000 grains for a twin. A typical "hard water" may contain from 5 to 15 grains per gallon.

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An unusual application for a new vibrating feeder has produced a remarkable increase in production and maintenance efficiency, as well as a more uniform product, at Loft Candy Corp., Long Island City, N. Y. Used for coating pecan crunch bars, the unit reportedly enables Loft to produce twice the daily amount of candy that its former hand-feeding system did. The unit, called the Velofeeder, and manufactured by Richardson Scale Co., Clifton, N. J., was designed and developed by Henry Simon, Ltd., of England. Moving at near resonance, it produces a gentle and uniform flow of material.

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Complete remote control operation of closed-circuit television cameras is provided by this unique "servo pan and tilt" system developed by Dage Television Division, Thompson Products, Inc. Designated the 285-A Servo System, it includes a multi-lens camera (left) which is completely controlled by a separate monitor-console (right). Controls in the console allow 3 "pre-set" pan and tilt positions to be selected instantly by pushing a button, or completely free flexible manual control by turning an appropriate knob. The pre-set positions may be changed. The remote control unit provides operator safety in hazardous locations, permits quick and accurate viewing of widely spaced objectives, and assures undetected operation in security and surveillance installations. Camera may be mounted on tripod or fixed in a permanent location. Price of the 2 units illustrated is approximately $3,550. Write the firm c/o Martin E. Janis & Co., 100 W. Monroe St., Chicago 3, Ill.

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A revolutionary dried egg product, introduced by Seymour Foods, Inc., 609 Quincy St., Topeka, Kansas, reportedly not only replaces frozen eggs but also produces food products of superior quality. Egglite is made as 4 dried egg products, each with a special purpose and a distinguishing name. Soft-n-lite is a highly refined albumen product, for angelfood and chiffon cakes. White-n-lite is a dried albumen product for other bakery products requiring egg whites, such as meringues. Brite-n-lite is a dried and fortified whole egg product, for bakery formulas requiring whole eggs, such as yellow cakes and jelly rolls. Rich-n-lite is a high solid yolk product for use in such sweet goods as Danish pastry and coffee cakes. The product is stated to be absolutely stable.

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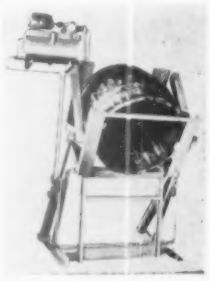

A new Hydraulic Barrel Dump introduced by F. H. Langsenkamp Co., 229 E. South St., Indianapolis, Ind., does the work of 15 to 20 men and provides complete hydraulic control at all tilt angles. The barrel to be emptied can easily be set into position within the dump unit by fork lift truck, and no clamps or hooks are needed to hold it in place during the dumping operation. The unit handles standard 55-gallon or 2,500-pound capacity barrels, adapts to any shape vessel, and requires just 30 seconds for full dump-and-return cycle.

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Unsanitary conditions can be detected and eliminated easily and surely with a new BLAK-RAY Public Health Inspection Kit marketed by Black Light Corporation of America, San Gabriel, Calif. The Kit utilizes black light and fluorescent materials to unmask contamination in many forms, employing the principle that most waste food products show some characteristic fluorescence. Rodents can be tracked down as well as faulty sewage systems and unclean washroom facilities. Materials include a black light lamp for use on both AC or DC, carrying case and batteries, invisible crayons, ink, paint, tracer paste, aerosol powder and dust gun, and mechanical pencil with invisible leads. A free pamphlet detailing the Kit's many applications is available.

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A new line of plastic floats, for applications in dairies, canneries, liquid level controls, float operated valves, bottling machinery, water columns, poultry and livestock watering devices, tanks, and water heaters (where temperatures do not exceed 160° F.), is announced by J. H. Shepherd Son & Co., 1820 East Ave., Elyria, O. Available in many shapes and sizes, they are mirror smooth for close tolerance operations and to prevent foreign substances or growths from adhering. High buoyancy, outstanding impact resistance, and even permanent colors, when required, are additional features.

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New tube fittings, molded from Du Pont "Zytel" (Nylon), **which can be used with either plastic or metal tubing, withstand temperatures from —70° F. to +250° F. as well as repeated steam sterilization,** are announced by The Imperial Brass Mfg. Co., 1200

FOOD INDUSTRY TOPICS

W. Harrison St., Chicago 7, Ill. Nylo-Seal Tube Fittings are 2-piece fittings, and the sleeve is an integral part of the nut. No flaring of tube is required. They can be used with stainless steel tubing as well as with nylon, polyethylene, aluminum, steel, and copper tubing. For food and beverage applications, they should be specified in Natural White color. Fittings normally are furnished in a Royal Blue, which makes them unusually resistant to weathering. The fittings are approximately $\frac{1}{7}$ the weight of brass, and are offered in sizes from $\frac{1}{4}$″ to $\frac{1}{2}$″ O.D., in unions, bulkheads, half unions, elbows, and tees. Write for Bulletin 3049.

. . . *the literary corner*

The first popular book on fermentation chemistry has been published by Chas. Pfizer & Co., Inc., 630 Flushing Ave., Brooklyn 6, N. Y. Entitled *Our Smallest Servants*, the hard-cover, 32-page book is illustrated in color with prints, photographs, drawings, and diagrams. It describes the progress of fermentation from its primitive stage as "art without science" to the contemporary period when selected mold organisms are controlled by the biochemical engineer for production of antibiotics, hormones, vitamins, and many valuable industrial and agricultural chemicals. This book, outstanding in appearance and skillfully composed, is being made available in the U. S. and abroad to public libraries, school and college libraries, students and teachers, writers and editors, and other groups interested in this aspect of scientific research and production.

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What's New in Food and Drug Research for October 1955, published by Food Research Laboratories, Inc., 48-14 33rd St., Long Island City 1, N. Y., yields its usual share of interesting and useful information under such titles as "Cyanocobalamin Yields its Secret to a Woman," "Hormone Feeding of Cattle Proves Successful," "First Advisory Committee Review of Pesticide Residue Tolerance," "International Vitamin Group Makes Progress," "Clinical Chemists Join Hands," "There Is Vitamin A and Vitamin A," and "Menadione Bisulfite Gains Momentum as Feed Fortifier."

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"Who is Atlas Powder Company?" asks the lead article in the firm's *Chemmuniqué*, Vol. 3, No. 6, November-December, 1955. The reason for the question . . . and the answer . . . is forthcoming quickly. Apparently the Ladies' Aid societies of two churches had written for gift packages of Atlas powder to give away as door prizes at forthcoming bazaars. As the article puts it: "Figuring that a stick of dynamite and numerous bottles of assorted chemicals would make a somewhat disappointing door prize, we diagnosed the case . . . as one of mistaken identity. The girls had mistaken us for makers of *face powder* and cosmetics, instead of *dynamite*, which is what the POWDER in our proud old name really stands for. . . . Back in the days when explosives were our only product, we would have gnashed our teeth in chagrin that anyone could so misidentify us. This time, however, our reaction was not entirely without pleasure, for the cosmetics industry is one of the biggest takers of our sorbitol and emulsifiers, and so, naturally, we are flattered to be considered a part of this industry." The firm is headquartered at Wilmington, Del.

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The October 15 issue of *Glycerine Facts*, published by Glycerine Producers' Assn. 295 Madison Ave., New York 17, N. Y., informs that production of synthetic glycerine, up to now an exclusive American chemical industry development, has taken on an international flavor with the impending building of a $6.6 million plant at the Pernis refinery near Rotter-

FUTURE MEETINGS FOR FOOD TECHNOLOGISTS

1956	
January 12-14	Council of Participating Institutions of Argonne National Laboratory: Conference on the Use of Isotopes in Agriculture, Michigan State University, East Lansing, Michigan
February 6-17	Ice Cream Short Course, North Carolina State College, Raleigh, North Carolina
February 21-24	Dairy Laboratory Short Course, School of Agriculture, North Carolina State College, Raleigh, North Carolina
March 13 and 14	Fourth Annual National Dairy Engineering Conference, Kellogg Center, Michigan State University, East Lansing, Michigan
March 15-16	First International Symposium on Physics in the Food Industry, the Institute of Food Technologists and the Southwest Research Institute, Sponsors, Plaza Hotel, San Antonio, Texas
March 16-17	Fourth Annual Food Technology Short Course for 1956, Campus of the University of Missouri, Memorial Student Union, Columbia, Missouri. For reservations contact Mr. Paul Logue, Monsanto Chemical Co. 710 North 12th Boulevard, St. Louis, Missouri
April 8-13	One hundred and twenty-ninth National Meeting of the American Chemical Society, Dallas, Texas
June 10-14	**Sixteenth Annual Meeting of the Institute of Food Technologists, Hotel Jefferson, St. Louis, Missouri**
June 18-22	International Congress on Food Distribution, Rome, Italy

dam by Bataafsche Petroleum Maatschappij. The Dutch firm, a Shell Oil affiliate, will use the process now employed by Shell Chemical Co., first synthetic glycerine producer, in its U. S. production. The foreign unit is expected to be on stream in 1957.

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"The American Taste in Cordials and Liqueurs," an article with the holiday touch, is featured in *The Givaudan Flavorist*, No. 5, 1955, published by Givaudan Flavors, Inc., 330 W. 42nd St., New York 36, N. Y. Particular attention is paid to the reasons for the widening gap between the American and the European industries.

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According to *Fatty Acid News Digest*, October 1955, published by Fatty Acid Division, Assn. of American Soap & Glycerine Producers, Inc., 295 Madison Ave., New York 17, N. Y., soybean and fatty acid operations, both previously part of the Chemical Division of General Mills, are now operating as separate entities.

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A new free catalog published by General Industrial Co., 5746 N. Elston Ave., Chicago 30, Ill., includes many new items added to General's standard line of steel shelving, lockers, storage cabinets, and intercommunication systems. Each item is illustrated and priced.

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Specification Sheet 866 describes new Honeywell Ambi-Stat remote bulb temperature controllers. These provide close control with compensation for temperature differences between controlled medium and air surrounding tubing and bellows. Write Minneapolis-Honeywell Regulator Co., Industrial Division, Wayne & Windrim Aves., Philadelphia 44, Pa.

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The American Industrial Hygiene Assn. *Quarterly* announces publication of a series of information bulletins, called "Hygienic Guides," designed to present authoritative and substantiated information on the toxicity of common industrial materials, as well as to bring together all pertinent information required for hazard evaluation. Each will contain the following information: maximum allowable concentration for both short- and long-term exposures; significant chemical and physical properties; major uses; evaluation of exposures; engineering control procedures; medical control procedures; and references to the literature. Guides are available for Acetaldehyde, Cadmium, Carbon Tetrachloride, Butyl Alcohol (N-Butanol), and Amyl Acetate. Guides covering all common industrial chemicals and materials are planned. Hygienic Guide sheets may be obtained from the Association, 14125 Prevost, Detroit 27, Mich., at 25 cents each. All orders for less than $2 must be prepaid.

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Behind the symbol of the Retort stands three generations of family pride and "know-how" in Essential Aromatics, natural and synthetic flavors, perfumer's specialties. Made in the West's most modern plant. The Retort is your guide to dependability.
F. Ritter & Co.
Los Angeles 39, California
Branch Offices in Principal Cities

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Technical literature available without charge from Southern Utilization Research Branch, USDA, 2100 Robert E. Lee Blvd., New Orleans 19, La., includes: (1) An abstract list of the publications and patents of the Branch for the first 6 months of 1955, including all areas of research in which the Branch is interested, and arranged according to subject, giving the title, authors, publication references, and a short abstract of the subject matter of each article; (2) a reprint reporting studies on sweet potato dehydration undertaken at request of the Quartermaster Corps and in cooperation with the Louisiana Agricultural Experiment Station; (3) a leaflet entitled, "A Method for Testing Cucumber Salt-Stock Brine for Softening Activity."

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Gearmotors mounted atop columns offer practical advantages over older arrangements for replacing line-shaft drives in food manufacturing and processing plants, according to an illustrated feature in the September 1955 issue of *Motorization*. Drawings show how the interesting mount is adaptable to a variety of machines and drive motors. The publi-

FOOD INDUSTRY TOPICS

cation is available from ACEC Electric Corp., 40 E. 49th St., New York 17, N. Y.

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The operation of Turbo-Dryers in closed circuit for continuous drying, cooling, or subliming materials which are fragile, obnoxious, heat sensitive, oxidizable, or wet with solvents that are hazardous or must be recovered is presented in new Bulletin 5507, offered without charge by Wyssmont Co., Inc., 42-09 27th St., Long Island City 1, N. Y.

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The F&P Figure 1050A Chlorinator for purifying water supplies, treating sewage and industrial wastes, and for control of slime is illustrated and described in 16-page Catalog 70-10 just published by Fischer & Porter Co., 539 Jacksonville Rd., Hatboro, Pa. A multi-colored flow diagram shows how chlorine gas and water are kept separate until they reach the ejector system. The catalog explains how this feature, together with the use of completely corrosion-resistant materials throughout the chlorinator, prevents corrosion of the equipment and makes it maintenance-free.

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Proceedings of the 1955 Short Course on Analytical Techniques, given by the American Oil Chemists' Society at the University of Illinois in August 1955, may be obtained in the form of a 115-page bound reprint at $3.00 each from the Society at 35 E. Wacker Dr., Chicago 1, Ill. Subjects covered are sampling, determination of impurities in fats and oils, determination of refining loss, bleach and color methods, melting point, solidification and consistency, flavor evaluation of fats and oils, stability and rancidity, performance testing, x-ray spectroscopy, infra-red absorption spectra, dilatometric measurements, chromatography, distillation, fractional solvent crystallization, analysis of lipids by counter-current distribution, microscopy of fats and oils, automation—instrumental analysis, statistics applied to research and control in the oil and fat industry, measurement of chain length, determination of unsaturation, determination of free hydroxyl groups in fatty materials, determination of triglyceride composition of fats, process control, and establishment of specifications.

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A revised catalog on its Quick-Seal line of quick connect-disconnect hose coupling has been released by Industrial Sales, Titeflex, Inc., 10 Hendee St., Springfield 4, Mass. Entitled "Quick-Seal Couplings," the 20-page catalog features page-size cutaway views of the couplings which reveal how this construction provides: (1) a unique sealing action which makes the coupling tighter as internal pressure increases; and (2) a full-swiveling action that prevents hose twisting and kinking. Also described are single-check and double-check valve modifications of the coupling which seal off one or both ends of a fluid line the instant the coupling is disconnected.

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"How Wire Construction Reduces Costs," showing use of wire in improved product design, is a study of 36 illustrated case histories compiled by E. H. Titchener & Co., 67 Clinton St., Binghamton, N. Y. The 11-page booklet covers such applications as motor mounts, fan guards, furniture, building specialties, and television components. Address requests on company letterhead, with title.

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Four-page bulletin SD-1, containing selection information for the Agastat time delay relay models, is announced by A'G'A Division, Elastic Stop Nut Corporation of America. The correct model for a particular time delay or combination of time delays in an electrical circuit may be chosen from a selection chart in the bulletin. Write the firm c/o G. M. Basford Co., 60 E. 42nd St., New York 17, N. Y.

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Skinless, shankless, and semi-boneless half-hams, and how to get increased profits from them, is the subject of new color booklet HHP, available from Cryovac Division, Dewey and Almy Chemical Co., division of W. R. Grace & Co., 62 Whittemore Ave., Cambridge 40, Mass. Both sales suggestions and production techniques are discussed.

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Pak-Facts for October 1955, published by Tee-Pak, Inc., 3520 S. Morgan St., Chicago 9, Ill., reports that at its annual fall meeting the National Flexible Packaging Association unanimously went on record to discourage reverse printing on transparent films where the ink or printed overcoating comes in direct contact with food products. The publication states that the Association made no objection to duplex bags made of film where the printing is separated from the food product by an unprinted liner.

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The Turba-Film (R) Evaporator for one-pass continuous concentration of heat-sensitive and viscous fruit products is described in 11-page Bulletin 33, published by Rodney Hunt Machine Co., Orange, Mass. Construction, operation, and installation, as well as how the evaporator can be used in conjunction with tubular evaporators, are described. Concentrations, product quality, evaporation rates, steam pressure, and vacuum conditions are outlined for orange juice, tomato paste, grape jelly and jam, apple jelly, apple pectin solution, grape juice, black raspberry

juice, red raspberry juice, grape pulp, and black raspberry pulp.

◆ ◆ ◆

Data Sheet Wa, from Allen-Sherman-Hoff Co., 259 E. Lancaster Ave., Wynnewood, Pa., describes construction and application of Ashcolite pipe and couplings for pneumatic and hydraulic materials handling systems. Advantages of this sand-spun pipe—uniform wall thickness, high resistance to wear (because of its retained crystalling structure) and freedom from blow-holes, sponginess, and warpage—are explained.

◆ ◆ ◆

An enlightening article entitled "Keeping Fish Fresh" graces the Fall 1955 issue of *SeaKem Extracts*, published by Seaplant Chemical Corporation, 63 David St., New Bedford, Mass. It seems that American Cyanamid Company chemists, searching for a means of preventing chlortetracycline (aureomycin) from "migrating" in the ice used to preserve freshly caught fish, found that no other hydrocolloid worked as well as carrageenin (SeaKem Type 9). The study has been set forth in a paper entitled "A Practical Method of Dispersing Aureomycin Chlortetracycline in Ice" by S. D. Upham, F. E. Stirn, J. F. Weidenheimer, F. M. Callahan, and L. Ritter.

◆ ◆ ◆

Insect infestation of grain, causing a loss of $300 million annually, now can be controlled by irradiation, trichinae in pork products can be destroyed, and microorganisms in potatoes can be rendered so inactive that potatoes can be stored for as long as 2 years without sprouting. These and other food irradiation facts and predictions appear in a recent issue of "Atomic Activities," published by National Securities & Research Corporation's Atomic & Electronics Division. To receive copies, write Albert Frank—Guenther Law, Inc., 131 Cedar St., New York 6, N. Y.

◆ ◆ ◆

A new catalog on Vanton Flex-i-liner Plastic Pumps is available from Vanton Pump & Equipment Corp., 210 Sweetland Ave., Hillside, N. J. Illustrations and diagrams of both standard and XB models, complete operating and performance data, materials of construction, and recommended application tables are included. Ask for Catalog No. 55.

. . . *meeting hall and conference room*

A 3-day Forum on Instrumentation in the Food Industry is scheduled for March 19-21 at the Foxboro Company, Foxboro, Mass. The second annual program of its kind, the forum provides for exchange of ideas and application information between Foxboro instrument engineers and instrument users in the food industry. Special attention will be given to quality measurements, such as viscosity and turbidity. It is planned to devote at least one session to evaluation of graphic type control panels as a tool for simplifying process operations and increasing operator understanding. The program will be of particular interest to processors of beet and cane sugar, grain products and corn products, brewers, confectioners, canners and packers, and food equipment manufacturers. Since openings in the forum are limited, attendance will be restricted to food men primarily concerned with profitable use of instruments. Apply to Mr. L. M. Richardson, manager of the firm's Food Industry Division.

◆ ◆ ◆

The 15th Training Conference sponsored by The Refrigeration Research Foundation, 200 Midland Bldg., Colorado Springs, Colo., will be held at Purdue University, Lafayette, Ind., January 22-26, 1956. Open to all interested in advancement of refrigerated warehousing.

◆ ◆ ◆

The Third International Congress on Food Distribution will take place in Rome, June 18-22, 1956. Brought about by the International Food Distribution Assn., Paris, and organized by the Italian General Federation of Commerce and by the Technical

SIX DECADES
OF SERVICE TO
FOOD TECHNOLOGISTS

60 years of specialized experience in the manufacture of powdered vanilla products

David Michael has long since mastered the special skills and techniques to create new and highly individual flavorings to fill any specific need, and have been the acknowleged leader in the vanilla field for 60 years.

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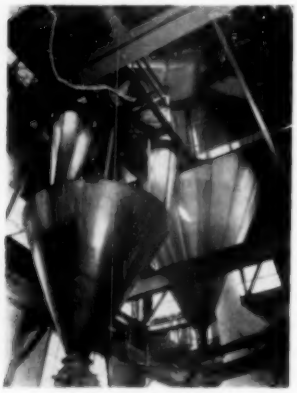
FOOD INDUSTRY TOPICS

Center for Commercial Productivity, the Congress succeeds those held in Paris (1950) and in Ostend, Belgium (1953), and its general subject, "Productivity in Food Distribution," will be a continuation of the research and the studies begun at the 2 preceding congresses. More than 2,500 persons from 22 countries will participate. For fuller information and registration forms, write: Alla Segreteria Generale, Del III Congresso Internazionale, Della Distribuzione dei Prodotti Alimentari, Lungotevere degli Anguillara, 9, Roma, Italia.

. . . *building up and branching out*

Norda Essential Oil and Chemical Company, Inc., 601 W. 26th St., New York 1, N. Y., has put into operation its new spray drying plant in Boonton, N. J. Although known for many years, spray drying is a comparatively recent development in preparation of dry flavors. Among advantages are constant uniformity, flavor-trueness, greatly decreased susceptibility to oxidation, rancidity, and evaporation. Norda's technical staff, in cooperation with the engineering staff of Nichols Engineering and Research Corp., designed, developed, and adapted to Norda's specific needs the famous system originated by Nyrop, the Danish engineer, about 30 years ago. Of the most modern design, the completely automatic spray drying plant incorporates all latest improvements and refinements, as well as some unique innovations. The future possibilities of this spray dryer reportedly are practically unlimited for newer and better flavors. In the near future, Norda will be offering spray-dried genuine fruit flavors with a life of several years—and spray-dried fruit juices with flavor quality almost indistinguishable from the fresh juice and shelf life far beyond anything known at present. Norda also will offer the whole spray-dried powdered fruit, useful for many new applications in packaged food products. It is expected that not only will the flavor industry experience a revolutionary change, but other related industries will benefit by advances now being made in use of spray-dried products.



. . . Cyclone (left) and main drying chamber (right) vividly showing size of unit.

Norda also announces purchase of all American assets of Heine & Co., internationally known manufacturers of perfume and cosmetic compounds. Heine & Co., originating in Leipzig, Germany, began U. S. operations in 1905. In 1946, under the Trading with the Enemy Act, the U. S. Government Alien Property Custodian seized the firm. Now, Heine's exquisite synthetic flower oils, such as Heiko-Lilac "A", Heiko-Jasminette White, Heiko-Pink, and all the Heiko creations (trademarked by the Heiko "tulip") again will be plentifully available. Mr. Frederick C. Keidel, well known in the industry, again will be chief perfumer of Heine & Co. Mr. Chester Tompkins will be in charge of sales. The firm will be located at 601 W. 26th St., New York 1, N. Y.

◆ ◆ ◆

From The Pfaudler Company, 100 West Ave., Rochester, N. Y., comes the following news: (1) An Applications Engineering Section has been established to meet industry's call on equipment suppliers to satisfy customer's specifications. As the firm explains: "Maximum performance is required of production equipment in an ever-widening scope of operations as a result of continuous and semi-continuous processing, batch processing, and specialization needed for performance determinations." (2) Engineering service to review specifications of installed attemperators will be offered without charge to breweries to help determine the most efficient size of attemperator for performance desired. The recommendations may enable inexpensive expansion of capacity and improvement of quality of the brew. (3) A contract agreement has been effected with Pitmar Corp., Baltimore, Md., to market the Titan Centrifuge in the chemical, pharmaceutical, food, and dairy process industries. Pitmar imports parts for the units from the Titan Corporation of Denmark, and will continue to assemble and service the units. Three models are available in capacities of 800, 2,000, and 7,500 gallons per hour. (4) Two appointments in the Engineering Department place Mr. John W. Cosier as engineer-in-charge of the newly formed Applications Engineering Section, and Mr. James D. Ross, Jr., as engineer-in-charge of the Project Engineering Section.

◆ ◆ ◆

Huron Milling Company has moved executive and sales offices from 9 Park Pl., New York City, to 3101

Do Not Forget to Pay Your 1956 MEMBERSHIP DUES

Professional Membership . . . $7.50
Student Membership $2.50

Remit to:

INSTITUTE OF FOOD TECHNOLOGISTS
176 West Adams Street
Chicago, Illinois

N. Woodward Ave., Royal Oak, Mich., according to Mr. Robert M. Farr, president. The firm processes food and allied food products, including monosodium glutamate. Other products include wallpaper paste and laundry starch. The company's plants are located in Harbor Beach, Mich.

◆ ◆ ◆

Pennsylvania Salt Manufacturing Company, 3 Penn Center Plaza, Philadelphia 2, Pa., has announced plans to enter the aerosol propellant and refrigerant fields late in 1955 with the Isotron line . . . a complete family of chlorofluorohydrocarbons. (Initial products will include trichloromonofluoromethane, dichlorodifluoromethane, and monochlorodifluoromethane.) The expansion is part of Pennsalt's long-range plans for consolidating its position in the fluorine chemicals industry, and to achieve further product diversification. The Isotron line will be produced in a multimillion dollar plant under construction at Calvert City, Ky.

◆ ◆ ◆

With the acquisition of a new building and machinery of the most modern design, Felton Chemical Co., Inc., 599 Johnson Ave., Brooklyn 37, N. Y., has embarked upon production of true fruit flavor extracts. Equipment manufactured under the direction of Felton technicians has been installed in a 3-story building adjacent to the main Felton plant. Expanding soft drink and ice cream consumption, and the use of true fruit extracts in pharmaceuticals and medicinal products resulting in the present enlarged market are pointed out as the reasons behind the expansion.

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Australian Prime Minister R. G. Menzies and Mr. H. J. Heinz II, president of H. J. Heinz Co., Pittsburgh, Pa., officially opened the new Australian factory of H. J. Heinz Company Pty., Ltd., at Dandenong, near Melbourne, on November 7. The plant, which will process the complete line of Heinz varieties, was built at a cost of approximately $9 million, and is believed to be the largest food processing facility in the Southern Hemisphere.

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The organization of Bjorksten Research Laboratories for Industry, Inc., to perform industrial and all other types of non-government research has been announced by Dr. Johan Bjorksten, president of Bjorksten Research Laboratories, Inc. Both companies are located in Madison, Wis., with branch offices in New York City, Chicago, Washington, D. C., Dayton, Houston, and Cleveland. In order to concentrate fully on the defense effort, Bjorksten Research Laboratories, Inc., will function as a special laboratory exclusively for the performance of contracts for branches of the Armed Forces and various government agencies. The latter firm also announces that Mr. Stuart O. Fiedler, vice president and technical director of the company from 1945 to 1947, has resumed the position of technical director.

. . . *the human element*

During the 50th Annual Meeting of the American Meat Institute, Chicago, the first Dodge & Olcott Achievement Award for outstanding contribution to the growth and general welfare of the meat packing industry was presented to Mr. Virgil R. Rupp, manager of quality control, Kingan & Co. Mr. Rupp (right, above) was honored for his development of a commercially practicable method of curing bellies by means of a multiple-needle pickle injection, called Injecto-Cure. The award, consisting of a check for $1,000 and a gold medal, was presented by Mr. H. H. Corey (left, above), president of George A. Hormel & Company and chairman of the Award Committee. Other members of the Committee included: Mr. E. B. Nattemer, editor and publisher of Meat Magazine; Mr. H. C. Diehl, director, The Refrigeration Research Foundation; Mr. H. D. Tefft, director, Department of Packinghouse Practice and Research, American Meat Institute; Mr. V. Conquest, vice president, Research Division, Armour and Company; and Dr. H. R. Kraybill, director, Research & Education, American Meat Institute Foundation.

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. . . **Duncan of Beckman to Berkeley**

Appointment of **Mr. Donald C. Duncan** as general manager of the Berkeley Division of Beckman Instruments, Inc., has been announced by the firm's president, Dr. Arnold O. Beckman, who also announced appointment of **Mr. Thomas Allinson** as manager of the Berkeley Division, located in Richmond, Calif. Mr. Allinson will report to Mr. Duncan who will continue to serve as general manager of Beckman's Helipot and Arga divisions in South Pasadena.

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Mr. Wm. A. Kissel, formerly sales representative for upper New York State and eastern Canada, has been assigned to the St. Louis office of Ungerer & Company, Inc., located at 532 Arcade Bldg., where he takes charge of that territory under the general supervision of Mr. J. L. Slais, Chicago district sales manager. The areas formerly covered by Mr. Kissel now are being serviced by **Mr. Warren E. Kell,** through the Ungerer Boston office.

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Mr. Robert B. Ball has been elected a vice president of The Diamond Crystal Salt Company. He has been plant manager of the St. Clair, Mich., plant since

FOOD INDUSTRY TOPICS

March 1953. At that time, the 69-year-old company was re-purchased by the Moore family from the General Foods Corporation, of which it had been a division since 1929. Mr. Chas. F. Moore, present board chairman and president, is the grandson of the founder. Mr. Ball joined the Salt Division of General Foods in 1929. In 1945, he was promoted to manager of Manufacturing and Engineering for The Diamond Crystal Salt Division, which position he held until March 1953.

◆ ◆ ◆

Dr. C. Richard Calkins of the technical staff of Riegel Paper Corp., 260 Madison Ave., New York 16, N. Y., has been advanced to director of research at the firm's 4 New Jersey mills. In his new position, he will be responsible for all research and development of glassine, greaseproof, converted, and industrial specialty papers. Dr. Calkins joined the paper firm upon graduation from the Institute of Paper Chemistry, Appleton, Wis., in 1949.

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Mr. Frank J. Fay, western sales manager of Food Machinery and Chemical Corporation's Canning Machinery Division, was honored in October by his firm for having contributed 40 years of service. Mr. Fay (at left), well known throughout the food processing industry, was presented with a diamond- and ruby-studded lapel pin at an annual Service Award dinner by Mr. Clifford K. Wilson (right), FMC vice president and Canning Machinery Division manager.

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Mr. Fred Lederer, a member of IFT,formerly assistant to the president of Adolf J. Mainzer, Inc., sends word that he has been admitted to practice before the U. S. Patent Office as a registered patent agent and that he is associated with Michael S. Striker, 511 Fifth Ave., New York 17, N. Y.

◆ ◆ ◆

American Can Company, New York City, announces the following recent executive appointments: **Mr. T. E. Alwyn,** formerly a vice president in the executive department, to vice president in charge of operations in the firm's Atlantic Division; **Mr. Lester W. Graaskamp,** from vice president in the executive department (and director) to vice president in charge of the Central Division—the company's largest division in manufacturing facilities and annual business volume—succeeding Mr. Michael P. Cortilet, who died last August; **Mr. John R. Henry,** formerly general attorney, to secretary and general counsel; **Mr. Roger F. Hepenstal,** formerly vice president in charge of manufacturing, to treasurer, succeeding Mr. Edmund Hoffman, who will continue to serve Canco in an advisory capacity; and **Mr. G. W. Reese,** formerly vice president in charge of the Atlantic Division, to vice president in charge of manufacturing for the entire company, succeeding Mr. Hepenstal. Mr. William C. Stolk, president of American Can Company, made the announcements.

◆ ◆ ◆

Mr. Michael J. Hickey has been appointed chemist in charge of quality control of perfume, essential oils, and other related raw materials of Florasynth Laboratories, Inc., 900 Van Nest Ave., New York 62, N. Y. Announcement was made by Mr. Joseph H. Fein, treasurer. IFT member Hickey has been associated with the essential oil field for the past 17 years.

. . . Hickey of Florasynth and IFT

◆ ◆ ◆

New officers of Lincoln Container Corp., Lincoln, Ill., include: **Mr. Maxwell J. Jones,** elected president and treasurer, to succeed Mr. Joseph M. Nester, who died in August 1955; **Mr. Ben F. Slater,** elected vice president, succeeding Mr. Jones; and **Mr. Leonard E. Sheppard,** elected secretary, succeeding Mr. Slater. Mr. Sheppard also is secretary of the Obear-Nester Glass Co.

◆ ◆ ◆

Miss Margaret Gibson, for the past 4 years home economist with the American Institute of Baking, Chicago, has been named director of the experimental kitchen of Henningsen, Inc., Springfield, Mo. A native of Wisconsin, Miss Gibson is a graduate of Stout Institute, from which she holds both a B.S. and an M.S. She taught home economics in Wisconsin high schools and served as a food specialist in the test kitchen of the Wheat Flour Institute, Chicago, before joining American Institute of Baking.

. . . a Gibson girl for Henningsen

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Mr. H. J. Everts, treasurer of Consolidated Foods Corp., has been elected a director and vice president of the company, according to announcement by Mr. S. M. Kennedy, president. Election of **Mr. Stacey H.**

(Continued on page 48)

...because they went to their doctors in time

Many thousands of Americans are being cured of cancer every year. More and more people are going to their doctors *in time*. That is encouraging!

But the tragic fact, our doctors tell us, is that every third cancer death is a needless death... *twice* as many could be saved.

A great many cancers can be cured, but only if properly treated before they have begun to spread or "colonize" in other parts of the body.

YOUR BEST CANCER INSURANCE is (1) to see your doctor *every year* for a thorough checkup, no matter how *well* you may feel (2) to see your doctor *immediately* at the first sign of any one of the 7 danger signals that may mean cancer.

For a list of those life-saving warning signals and other facts of *life* about cancer, call the American Cancer Society office nearest you or simply write to "Cancer" in care of your local Post Office.

American Cancer Society

FOOD INDUSTRY TOPICS

(Continued from page 46)

Gifford, secretary and counsel of Consolidated Foods since 1953, as vice president also was announced by Mr. Kennedy.

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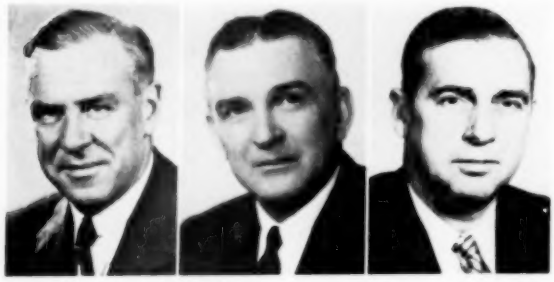

. . . three V.P.'s for CCC . . . Perin (left) . . . McJunkins (center) . . . and Blinn . . .

The board of directors of Continental Can Company, 100 E. 42nd St., New York City, has elected **Mr. Thomas C. Fogarty** president of the company, effective January 1, to fill the vacancy created by the retirement of Mr. Hans A. Eggerss. Mr. Fogarty has been a member of the board of directors since 1951. Announcement was made by Gen. Lucius D. Clay, board chairman. Three other Metal Division promotions became effective on the same date. **Mr. Reuben L. Perin,** previously vice president of the Eastern Division, is the newly-elected vice president of the Metal Division, the position held by Mr. Fogarty since 1950. **Mr. Orren R. McJunkins,** formerly general manager of the Southeastern District, was promoted to vice president in charge of the Eastern Division. **Mr. Horace M. Blinn,** who had served as general manager of the California District of the Pacific Division, was elected vice president in charge of that division to fill the vacancy created by the retirement of Mr. Sherlock McKewen.

. . . and a president . . . Fogarty

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Recent appointments and promotions announced by the Central Laboratories of General Foods Corporation, Hoboken, N. J., include the following: **Dr. J. Chas. Cavagnol,** formerly with Lederle Division of American Cyanamid Company, to laboratory director in food analysis; **Mr. Varnum D. Ludington,** formerly with Clapp's Baby Food Division of American Home Foods Corporation, and recently section head in the product and process development area of General Foods' Central Laboratories, to assistant laboratory director for product development; **Mr. David E. James,** recently with Edmont Mfg. Co., Coshocton, O., to section head of engineering and commercial development; **Messrs. Stephen W. Bogyo, Sigmund Hoffman,** and **Robert L. Roberts** to project leaders in product development; **Mr. Walter H. Harte** to associate technologist in engineering research.

◆ ◆ ◆

Mr. John F. Shea, vice president in charge of sales, Becco Chemical Division, Food Machinery and Chemical Corp., Buffalo, N. Y., has announced appointment of **Mr. Albert L. Shutts** as manager of the firm's New York territory, covering Vermont and parts of New Jersey, Massachusetts, Connecticut, and New York State. Headquarters for the territory is located at 420 Lexington Ave., New York 17, N. Y.

. . . new opening for Shutts at Becco

◆ ◆ ◆

Dr. Roger W. Truesdail, president of Truesdail Laboratories, Inc., Los Angeles, has been appointed columnist for the Rotary Club national monthly magazine, *The Rotarian*. Entitled "Peeps at Things to Come," IFT member Truesdail's column will deal with latest developments in science, progress in new materials, products, and applications.

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FOOD INDUSTRY TOPICS

Dr. Maurice E. Kinsey has been elected vice president in charge of plant operations for Tee-Pak, Inc., 3520 S. Morgan St., Chicago, Ill.,

... Tee-Pak's new V.P. ... Kinsey

manufacturers of casings for sausage products and packages for other foods, it was announced by Mr. Seymour Oppenheimer, president. Dr. Kinsey formerly was plant superintendent. Announcement was made also that **Mr. William Gall** has been named production superintendent, and **Mr. Reid Bennett** technical superintendent. Both formerly were assistants to the plant superintendent.

◆ ◆ ◆

Durethene Corp., one of the nation's largest producers of polyethylene film, recently announced election of **Mr. Carl A. Raabe** as president and director. Mr. Raabe was with American Phenolic Corporation for the past 17 years as general manager of that firm's Cable and Synthetics Division, one of the largest polyethylene coaxial cable producers. Durethene's main plant is at 1859 S. 55th Ave., Chicago; their West Coast plant is at 5600 W. Arbor Vitae St., Los Angeles.

◆ ◆ ◆

Mr. Donald W. Hill, vice president of Crown Cork & Seal Company, Inc., Baltimore, Md., and general manager of the firm's Specialty Division at St. Louis, Mo., has been promoted to vice president and general manager of the Crown and Closure Division, it was announced by Mr. Geo. W. Crabtree, executive vice president. Mr. Hill, a company director since 1953, will be located in the Division's Baltimore headquarters.

● *Unsolved Problems in Food and Nutrition Research*

Processing and Storage Problems

Fundamental studies on pigments in foods with particular emphasis on maintenance of color in certain canned products.

The adequacy of canned foods with reference to the B vitamins.

A study of the nitrate content of canned foods as related to possible physiological effects.

Study of factors influencing the retention of thiamine during the production of canned foods.

Stability of nonascorbic acid reducing substances in canned foods.

Chemistry of ascorbic acid destruction in canned foods during storage.

Stability of added vitamins in canned foods during processing and storage.

Influence of canning procedures on the more recently identified nutritive factors.

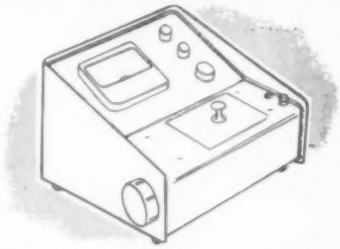
Quality improvement in frozen prepared foods: baked and unbaked flour mixtures, creamed and stew type dishes, dessert type preparations.

Cause of deterioration in unbaked, frozen yeast doughs and its prevention.

Excerpted from the SURVEY OF FOOD AND NUTRITION RESEARCH IN THE U.S.A., 1952-53, Food and Nutrition Board, National Research Council.

BECKMAN
BULLETIN DIGEST
NUMBER 5

SUGAR WHITENESS MEASUREMENTS with COLORIMETER



Here is the new Beckman Sugar Colorimeter—it provides a quick and accurate way to describe sugar whiteness so that everyone using it can obtain Color Index Numbers which are directly comparable. Now suppliers and users can talk the same language, with great ease! The Beckman Sugar Colorimeter was designed in close cooperation with the sugar industry . . . three years and several model changes were required before the industry committee gave its okay. Their latest report, to be released soon, says ". . . gives close agreement with the Beckman Model DU Spectrophotometer."

The Sugar Colorimeter comes complete with filters and two 10cm sample cells . . . all ready to use. The instrument is standardized with a colorless sugar solution or with distilled water . . . the sugar sample is dissolved in distilled water and absorbancy measured with the 420 $m\mu$ filter. Turbidity is measured with the 720 $m\mu$ filter, and subtracted from the first reading. Applying a simple formula gives Color Index . . . a number which will have the same meaning to a sugar refiner, a soft drink bottler, an ice cream maker, a baker or a confectioner.

A reprint of the first report of the sugar industry committee is yours for the asking. Your Beckman dealer will be glad to show you the Sugar Colorimeter in action . . . he'll even bring the sugar.

Your Beckman Dealer will be glad to demonstrate the Sugar Colorimeter as well as the Clinical Colorimeter, Flame Photometer, pH Meters and Spectrophotometers. For further information on the Sugar Colorimeter ask for Bulletin 68-84

Beckman Division
BECKMAN INSTRUMENTS, INC.
Fullerton 1, California

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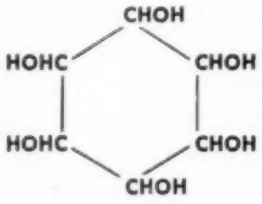
... for Chemical Synthesis and Lipotropic Preparations



INOSITOL

A recognized member of the B-Complex vitamin group, Inositol has several applications in the pharmaceutical industry. It is used either alone or with certain vitamins, as a lipotropic agent. The six hydroxyl groups in the molecule lend themselves to esterification and ether formation. And Inositol is also used in chemical synthesis. It is a product that holds great promise, not only for medicine, but for many fields of industry.

You can depend on Staley, one of the leading corn processors and chemical manufacturers, to supply your needs for a high grade, pure Inositol compound. At your request, Staley will be glad to send complete data, or to meet with you to discuss your Inositol requirements.

For information about other quality Staley pharmaceutical products; Corn Steep Liquor, Corn Syrups, Amino Acids, Starches, Lecithin, etc., write:

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INTERESTED IN WRITING?—"Food Processing" magazine has an opening on its editorial staff for a food technologist with some engineering training or a chemical engineer with experience in the food industries. Salary commeasurate with ability. Send resumé of training and experience. Reply will be held confidential. Address: The Editor, "Food Processing," 111 East Delaware Place, Chicago 11, Ill.

WANTED: Food Technologists and Chemists with advanced degrees and experience for research and development positions in an interesting and expanding food industry. Only superior type personnel will be considered. REPLY BOX 454, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

CHEMIST
OR
FOOD TECHNOLOGIST

For laboratory work and liaison between laboratory and sales in newly created Product Development Department. Five to ten years experience in shortening or baking fields necessary. Outstanding growth potential. ATLAS POWDER COMPANY, WILMINGTON, DELAWARE. Please direct all replies to R. L. Herrman, marked personal.

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Drake Personnel, Inc.
Room 628
HArrison 7-8600
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AVAILABLE: FOOD TECHNOLOGIST. B.S. Botany, M.S. Bacteriology, Ph.D. Bacteriology and Enzymology. Age 35. Experience 7 yrs. Research and Product Development with firm producing diversified food products. Prefer Research and Administration. REPLY BOX 456, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

POSITION WANTED: Quality Control Supervisor. Six yrs. exp. in processing and freezing frozen fruits and vegetables. Some production work. Member IFT. Desires position with growing concern. REPLY BOX 455, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

AVAILABLE: Food Technologist (Cal., '49). At present Assistant Production Manager Citrus Processing plant abroad. Experience quality control, production supervision in Citrus Juices, squashes, drinks, other by-products; also tomato processing. Desire suitable position in the U. S. REPLY BOX 453, Institute of Food Technologists, 176 W. Adams St., Chicago 3, Ill.

WANTED: Food Technologist or Chemist for research and technical sales service work on edible fats and oils and their use in food products of all kinds. Well established firm with rapidly expanding research facilities. At present located in Sherman, Texas, moving new quarters to Dallas near future. Send resume and photograph to Mrs. Tucker's Foods, Inc., Sherman, Texas.

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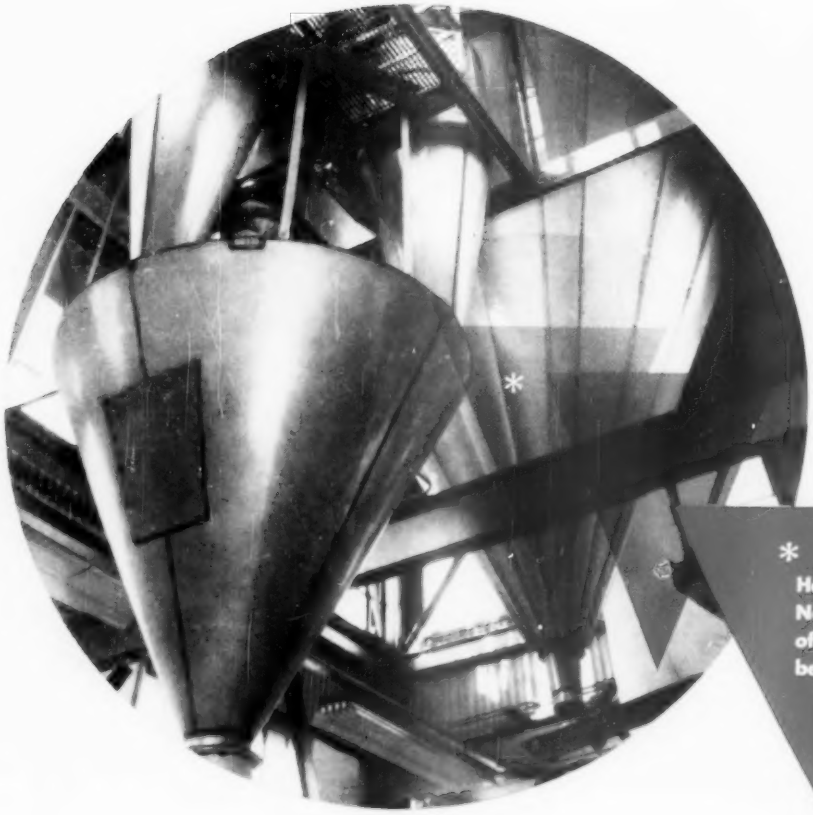

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